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AUTHOR	Sharples, D. Kent; And Others
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ABSTRACT

An individually-paced, open-entry/open-ended mastery learning approach for a state-wide civil engineering technology curriculum was developed, field-tested, and evaluated. Learning modules relying heavily on audiovisuals and hands-on experience, and based on 163 identified competencies, were developed for 11 courses in the curriculum. Written modules forming a linear progression through a series of related objectives were prepared by instructors from the South Carolina Technical Education System; alternate media forms were developed to supplement the written modules. Evaluation of the curriculum was accomplished through a pretest/posttest design comparing the individually-paced method and a lecture-based method. Subjects of the study were 250 male engineering technology students; 220 in South Carolina technical colleges and 30 in a North Carolina community college. Evaluation results indicated that the individually-paced students did relatively well in terms of cognitive achievement and outperformed the lecture-based students in terms of student exit behaviors. Students did not tend to procrastinate more in individually-paced courses than in lecture-based courses. Some disadvantages were noted; particularly the instructor/student ratio. Course-related and evaluation materials are appended. (Author/JDS)

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INDIVIDUALLY-PACED LEARNING IN CIVIL ENGINEERING TECHNOLOGY: AN APPROACH TO MASTERY

D. Kent Sharples, Project Director
James D. Smith, Jr., Associate Director
Gregg M. Strasler, Research Associate

STATE BOARD FOR TECHNICAL AND COMPREHENSIVE EDUCATION
COLUMBIA, SOUTH CAROLINA

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INTRODUCTION

In 1972, the South Carolina General Assembly passed Act 1268 which created the State Board for Technical and Comprehensive Education. The newly created State Board replaced the existing State Advisory Committee for Technical Training and was given jurisdiction over all two-year, state supported, post secondary institutions and programs except for the University of South Carolina and Clemson branch campuses. During its formative years as an advisory committee and following its elevation to Board status, the system grew to its present total of sixteen technical colleges and centers (see Figure 1). Under the supervision of local area commissions and the guidance of the State Board, these institutions provide a comprehensive state-wide educational system (TEC). The underlying theme for the development of TEC has been its commitment to train highly qualified technicians to meet the needs of new and expanding industry.

Over the years, TEC has become a strong leader in technical education offering the advantage of a built-in consortium with an aggressive State Board providing leadership to the sixteen institutions as they in turn provide valuable technical training for the people of South Carolina.

Typical of the developmental leadership the State Board provides for the system is the state-wide curriculum development project in Civil Engineering Technology. In 1973, the State Board, through its Division of Educational Services, received a National Science Foundation grant to develop an individually-paced instructional format for the state-wide Civil Engineering Technology curriculum in South Carolina. The grant was funded for thirty-nine months and was administered through the

Foundation's Science and Engineering Technician Education Program.

The project was designed to accomplish three basic objectives:

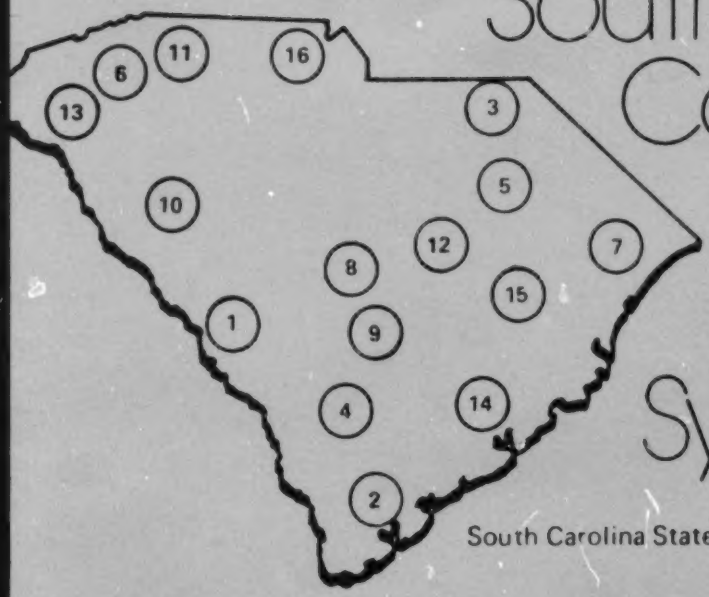
1. to identify the specific competencies required of a civil engineering technician,
2. to develop an individualized, self-pacing instructional format complete with software and equipment, and
3. to test and validate all items being developed.

The ultimate goal of the project was to develop a learner-oriented, open-entry/open-ended instructional format which relied heavily on the uses of audiovisuals and hands-on experience.

SIGNIFICANCE AND SCOPE OF THE ORIGINAL PROPOSAL

The original project, as funded by NSF, addresses itself to several educational problems of national concern, specifically student recruitment, attrition, and the problem of dealing with varying student ability levels within a given course curriculum. The concept of the individually-paced curriculum in this project is directly aimed at the alleviation of such problem areas.

It is hypothesized that the need to seek out and recruit interested students will be aided by an individually-paced curriculum which would enable a student to enter the program at any point during the year even though the introductory courses might not normally be scheduled at the time he wishes to enter. Furthermore, the inherent flexibility of the individually-paced curriculum is particularly valuable in enticing working students and others who may need to make special time arrangements not possible under traditional education programs.



South Carolina's Technical Education System

South Carolina State Board for Technical and Comprehensive Education

TECHNICAL EDUCATION

1 Aiken Technical Education Center
Post Office Drawer 696
Aiken, South Carolina 29801
Phone 593 9231

2 Beaufort Technical Education Center
100 S. Ribaut Road
Beaufort, South Carolina 29902
Phone 524 3380

3 Chesterfield Marlboro
Technical College
Drawer 928
Cheraw, South Carolina 29520
Phone 537 5286

4 Denmark Technical Education Center
Denmark, South Carolina 29042
Phone 793 3301

5 Florence Darlington
Technical College
Post Office Box 8000
Florence, South Carolina 29501
Phone 662 8151

6 Greenville Technical College
Post Office Box 5616, Station B
Greenville, South Carolina 29606
Phone 242 3170

7 Horry Georgetown
Technical Education Center
Post Office Box 710
Conway, South Carolina 29526
Phone 347 3186

8 Midlands Technical College
Airport Campus
West Columbia, South Carolina 29169
Phone 796 8401
Beltline Campus
316 Beltline Boulevard
Columbia, South Carolina 29205
Phone 782 5471

9 Orangeburg Calhoun
Technical College
Post Office Drawer 1767
Orangeburg, South Carolina 29115
Phone 536 0311

10 Piedmont Technical College
Drawer 1208
Greenwood, South Carolina 29646
Phone 223 8357

11 Spartanburg Technical College
Post Office Drawer 4386
Spartanburg, South Carolina 29301
Phone 576 5770

12 Sumter Area Technical College
506 Guignard Drive
Sumter, South Carolina 29150
Phone 773 9371

13 Tri County Technical College
Post Office Box 87
Pendleton, South Carolina 29670
Phone 225 2250

14 Trident Technical College
North Campus
7000 Rivers Avenue
North Charleston, South Carolina 29406
Phone 553 2375
Palmer Campus
125 Bull Street
Charleston, South Carolina 29401
Phone 722 0531

15 Williamsburg Technical, Adult
and Vocational Education Center
P.O. Box 640
Kingstree, South Carolina 29556
Phone 354 7423

16 York Technical College
U.S. Highway By Pass 21-A
Rock Hill, South Carolina 29730
Phone 328 3843

Figure 1. Location of South Carolina's sixteen technical education colleges and centers.

Another hypothesis of this project is that the diversity and resultant enthusiasm generated by a creatively engineered, individually-paced curriculum will attack the problem of student attrition more efficaciously than the traditional teacher-oriented approach. A student using an individually-paced packet of learning materials is made aware of the objective and the necessity of each unit being studied and is thereby involved in the total learning process rather than simply being the recipient of it. The "hands-on" experiences aimed for in this project can transform theory into reality for the work-oriented student. The diversity of the learning techniques utilized within the self-paced curriculum is directed at the creation and retention of student interest in the various subject areas being covered. Should a student fail to meet necessary course objectives, the individually-paced concept gives him a viable alternative to dropping out of the program by enabling him to repeat courses or segments of courses without suffering the loss of time which usually accompanies the repetition of a course.

It is further hypothesized that the individually-paced curriculum will positively affect the students' level of success by recognizing and allowing for their individual abilities within any given area. Under this concept, a student can be met at his present level of proficiency, and progress from that point at his own rate.

Furthermore, not all students learn best by listening and reading. The instructional format implemented under this student-oriented strategy is designed to provide a multi-media approach to learning in an attempt to successfully reach students with varying degrees of verbal skills.

An adequately developed individually-paced program should allow students to independently choose, initiate, and follow through a specific learning technique on a given subject, thus allowing the instructor to serve, not as the traditional disseminator of knowledge, but rather as a resource expert in the field who is able to give individual attention when needed.

ORGANIZATION AND ADMINISTRATION

The project was staffed with a Director in March of 1973. Soon after, the faculty in the ten institutions which offer the Civil Engineering Technology (CET) program were organized to form a nucleus of course content experts.

An Associate Director was employed in June of the same year to coordinate the development of audiovisual materials. Preliminary meetings of the organized faculty unit resulted in agreement on the courses that would constitute the core curriculum in Civil Engineering Technology.

The courses included in the core curriculum and adopted as target areas for the project are:

1. Statics
2. Strength of Materials
3. Structural Concrete
4. Structural Steel
5. Surveying I
6. Surveying II
7. Cost Estimating
8. Highway Design and Construction
9. Hydraulics
10. Water and Sewerage Systems
11. Soil Mechanics

DEFINING COMPETENCIES

When a consensus had been reached by the faculty members concerning the specific courses to be developed, the project staff set about determining the

core content of each course. To accomplish this objective, a series of meetings was held with the faculty committee. In preparation for these meetings, each school was asked, through their civil engineering Department Heads, to submit their existing course objectives. These objectives were reproduced and complete sets were returned to all CET faculty members so that each instructor was aware of other programs within the consortium. During subsequent faculty meetings, each instructor participated in the process of identifying those objectives which should be consistent among all ten schools. The end result of this series of meetings was a comprehensive task analysis of the core curriculum which resulted in a collective list of 163 competencies for the eleven courses in the CET program.

The next task was to verify that the 163 competencies identified by the consortium faculty were consistent with the needs of potential employers throughout the state. A second round of meetings was organized between representatives of faculty and industry. Although time consuming, these meetings provided a valid and realistic list of competencies required of a civil engineering technician.

SELECTING A FORMAT

By June of 1973, the preliminary task analysis had been completed and a format for writing the instructional material for each course needed to be selected. Since most of the available texts relating to the project's areas of concentration are written for the student seeking a baccalaureate degree, it was decided that the instructional units must be self-contained with little or no reliance on existing texts. It was also decided that the instructional units should be based on the concept of mastery learning

with heavy emphasis on hands-on experience. After a careful analysis of our needs and the available predetermined methods for preparing self-instructional materials, the techniques developed by Drs. Stuart and Rita Johnson, Chapel Hill, North Carolina, were selected. Basically, their system is designed around a self-instructional book that has been written to guide an instructor through the process of producing and testing a small self-instructional unit or package. This book, entitled Assuring Learning with Self-Instructional Packages or Up the Up Staircase[1], was the focal point of a workshop for the faculty organized in June 1973, to:

1. introduce or reemphasize the concept of mastery learning to all the faculty,
2. identify the strongest supporters of the project, and
3. identify potential writers for the project.

With the list of identified competencies, an acceptable writing format, and the faculty involved and familiar with the project, we were ready to begin writing.

SELECTING THE WRITING STAFF

Since the development of the materials would necessitate a thorough knowledge of the entire spectrum of the civil engineering curriculum, it was decided that the writing could best be accomplished by subcontracting several course content specialists. A major decision concerning the method of writing dealt with the problem of whether to contract the writing to highly trained content specialists outside the system, or to use exclusively the pool of system-wide instructors with their more general backgrounds and

1 Johnson, Stuart R. and Rita B., Assuring Learning with Self-Instructional Packages or Up the Up Staircase (Reading, Mass: Addison-Wesley Publishing Co., 1973).

experiences. Content specialists offered the advantage of more developed writing skills combined with a knowledge of the most current technical information. The faculty members, on the other hand, were familiar with the capabilities of the students for which the material would be prepared. Additionally, instructors at each institution, through continued close contact with their preestablished local industrial committees, could evaluate instructional content according to the needs of industry.

The results of the first workshop showed that approximately seventy-five percent of the faculty members were extremely interested in the project and eager to participate in the writing. Because of the high percentage of willing faculty participants and their understanding of the student population as well as local industrial needs, it was decided that faculty members should be the principal authors of the Civil Engineering Technology curriculum with the University of South Carolina faculty serving as consultants. This approach offered the advantages of both groups. It provided the project with material prepared for technology students by technology instructors and edited and proofread by highly trained specialists. Occasionally, this approach was somewhat more time consuming than anticipated since portions of the original material required substantial revisions. However, it did provide a method for maintaining accountable instructional materials, and consequently, it was well worth whatever additional time was required.

DEVELOPING THE WRITTEN MATERIALS[1]

A key project strategy for the development of instructional material

[1] Figure 2 depicts the basic developmental steps taken for each course.

	SURVEYING I	SURVEYING II	STATICS	HIGHWAY DESIGN	COST ESTIMATING	STRENGTH OF MATERIALS	STRUCTURAL STEEL	REINFORCED CONCRETE	SOIL MECHANICS	HYDRAULICS	WATER AND SEWERAGE
CONCENSUS ON COURSE CONTENT											
CONTRACT WRITER											
COURSE OBJECTIVES DEVELOPED											
STAFF REVIEW OF OBJECTIVES											
REVIEW BY INDUSTRIAL REPRESENTATIVES											
WRITTEN MATERIAL IS DEVELOPED											
STAFF REVIEW AND EDIT											
BASIC ILLUSTRATIONS ARE INCORPORATED											
REVIEWED BY REVIEW COMMITTEE											
STAFF INCORPORATES REVIEW COMMITTEE											
COMMENTS AND EDITS											
TYPED FOR WALK-THROUGH											
ADD PHOTOGRAPHS AND OTHER ILLUSTRATIONS											
PROOFREAD											
ARRANGE FOR WALK-THROUGH--CLASS OF 6-10											
CONDUCT WALK-THROUGH											
EVALUATION BY STAFF, STUDENTS AND FACULTY											
IDENTIFY PROBLEM AREAS											
DEVELOP NEEDED SUPPORTING MEDIA IF REQUIRED											
REVISE WRITTEN MATERIAL IF NEEDED											
COORDINATE WRITTEN MATERIAL AND MEDIA											
PRINT FOR FIELD TEST											
FIELD TEST COMPLETE WITH SUPPORTING MEDIA											
	PHASES I & II 27 MO.								PHASE III 12 MO.		

Figure 2 - Itemization of the developmental steps taken for each course.

was to maintain a degree of flexibility that would allow rapid movement to compensate for needed talent on a short-term basis. For example, the approach selected for this project was to maintain a small core of full-time professionals at the State Board to administer and coordinate the material development and to supplement the authors' efforts with consultants and part-time employees. This arrangement has been successful since there are specific talents required to write each course. Hiring supplemental help as needed allowed the Project Director to design a staff around the characteristics of the course and its author.

Generally, the part-time help that was required falls into one of the areas listed below:

1. artist/cartoonist
2. technical illustrator
3. technical editor
4. script writer

All individuals employed under these circumstances were contracted and compensated on a per unit produced basis. In all cases, remuneration was made only upon successful completion of the objective and acceptance of the work by the Project Director.

The first step in the development of the written materials was to conduct an evaluation of interested TEC faculty members to determine the most qualified person to write the material for each subject area.

A detailed contract was signed with each author as the writing of instructional material for the competencies associated with each course was assigned. The contract outlined the specific procedures and deadlines each author must follow in submitting his work. There were also quality

requirements with built-in checks to guarantee the highest quality of work possible from each author. The contract also included procedures to follow in case either party wished to withdraw from the contract for reasons of unresolved disagreements or inability to complete the work. This portion of the contract has been used only twice. In both cases, the problem was easily and satisfactorily resolved since both parties understood the procedure before entering into the contract.

Under the provisions of the contract, the author's first duty was to develop a list of objectives from the existing competencies for his content area. These objectives were scrutinized by the project staff and the instructors from participating institutions. When complete, each objective then became the theme around which an instructional module was developed.

Before a rough draft of each module was accepted, it was reviewed by the project staff and a select group of institutional faculty. At this stage of development, the review was conducted to determine the accuracy of the content and the appropriateness of the sequencing. No attempt was made at this point to judge the module's classroom effectiveness. Each author was obligated to conduct one revision, if required, as part of his contractual obligation.

EVALUATION OF THE WRITTEN MATERIALS

As the written material for each course was completed, the long process of validation by field test began. Each module was first scrutinized by a consultant from the University of South Carolina who was an expert in that particular area. The purpose of this edit was to utilize the writing skills of highly trained experts to rewrite or reorganize any

weak points in the module.

The next step involved identifying an instructor and a group of students to participate in the field testing of each module.

Although conducted under less than ideal conditions, the project's main concern with field testing was to attempt to validate self-instructional material in a conventional classroom setting which provided the opportunity for thorough observation of student reaction to each module.

When possible, the project staff monitored the class and recorded the questions and comments of all students as they progressed through the modules. When a project staff member could not attend a "walk-through" class, the instructor was asked to record the necessary information on a form. Although using instructors to record student reactions expedited this phase of evaluation, it has proven to be less informative than the reactionary data obtained by project staff members who, unhindered by the individual problems which must be handled in a class of ten to fifteen students, were free to direct their entire efforts to the evaluation process.

The results of this phase of the development process were extremely helpful in the revision of problem areas within the modules. A careful analysis of student comments provided insight into those areas in the module which confused or were misunderstood by the students. These problem areas were closely examined by the project staff to determine if the written material lacked adequate instructions or was improperly sequenced, and if required, the module or parts of it were edited for a second time. If the problem module was ascertained to be well written and content valid, the difficulty encountered by the students usually was in the complexity of

the concept or in the method of presentation. For example, some concepts within the module could have been rewritten in greater detail thereby helping those students who had difficulty understanding the material. However, addition of more material frequently made that portion of the module too long and boring for the majority of students who had no difficulty understanding the information in its original form. In these cases, alternate forms of instruction were required to support the printed modules.

MEDIA DEVELOPMENT

Although the grant makes specific reference to heavy reliance on multi-media, the position taken by the Project Director was to allow the instructional effectiveness and the cost determine the medium to be used. If, for example, a concept can effectively be learned through the medium of printed material, the most inexpensive form of media, then it is difficult to justify spending large sums of money to develop the same concept in a more expensive format.

The basic format for each course was a combination of written modules that formed a linear progression through a series of related objectives. The linear progression of written material was broadened by a series of alternate media developed for points of difficulty as identified by the analysis of the walk-through results. As illustrated in Figure 3, these alternate media forms provided a branching effect for the student who had difficulty understanding the concept in its more condensed version in the module.

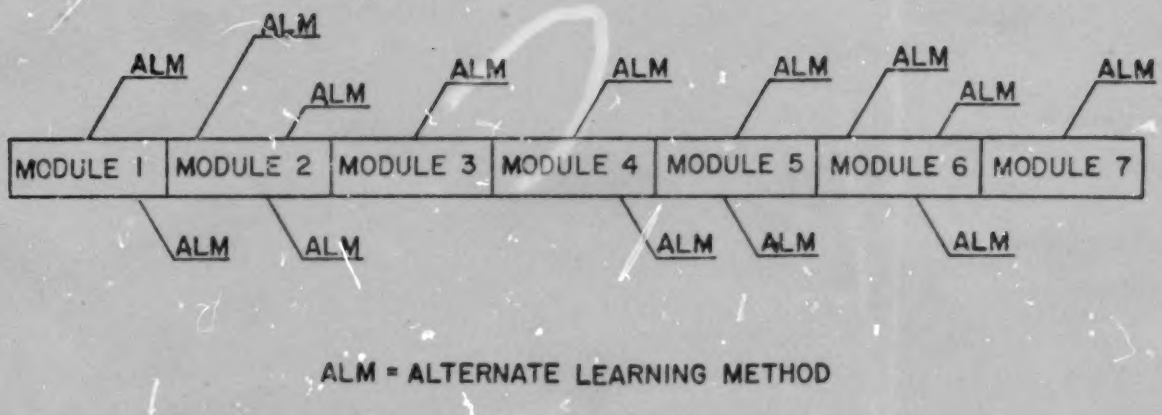


Figure 3. The use of alternate media forms to supplement written modules.

Each supplemental presentation takes a part of the module, usually a single task or concept, and expands the information in great detail, thereby offering the student an alternate learning method. It is, however, possible for a student who encounters no difficulty working through the module to complete a module or modules without utilizing any of the supplemental film presentations. It is also possible that the results of the walk-through would show that no additional support material was required.

As the results of the walk-through began to show evidence of needed supplemental material, the project staff began examining alternate media forms that could be utilized. At this point in the development, the only decision that had been made was to shift from the written format used for the modules to a non-reading visual format. The criteria of effectiveness and cost were again used to evaluate visual formats such as 35mm slides, super eight and video tape.

Two issues associated with learning effectiveness had to be resolved:

1. advantages of still frame vs. motion, and
2. advantages of color vs. black and white.

Four issues relating to cost had to be resolved before a final decision could be made:

1. cost of production and reproduction of media presentations,
2. cost and ease of making revisions and corrections,
3. quantity and type of audiovisual equipment existing in the ten participating institutions, and
4. type of hardware necessary to implement presentations.

Resolution of these questions resulted in the conclusion that 35mm color slides were the most efficient and least expensive of the commonly available formats. Except for limited occasions, still frame is just as effective as motion and the cost of 35mm slides is considerably less than super eight or video tape. Also, since there has been research supporting the concept of learning through the use of color, it was decided that the additional expense for color slides could be justified. The 35mm slides also offered the advantage of lower reproduction costs.

Another significant factor that influenced the decision was the ease with which slide-tape shows could be revised. This advantage was considered valuable since it was the intention of the project staff to develop flexible, easily edited materials that were free of the built-in limitations inherent in hard-bound, expensive texts and films. Finally, an analysis of existing hardware in the ten participating institutions and the purchase price of new equipment also supported the adaptation of 35mm sound-slide format.

Once the medium had been selected, the format for the presentations was developed. It was decided that to be consistent with the phiolsophy of mastery learning, the student must have the prerogative of reviewing the material presented. Therefore, the sound-slide presentations would be developed in the same cyclical style as the modules. As illustrated in Figure 4, information would be introduced, a question would be asked to reinforce the information, and immediate feedback would be provided. If a student missed a practice problem, he would be instructed to back-up several frames for a review. This technique provided a cyclical effect to an otherwise linear program. The addition of the media presentations made a complete instructional program for each course.

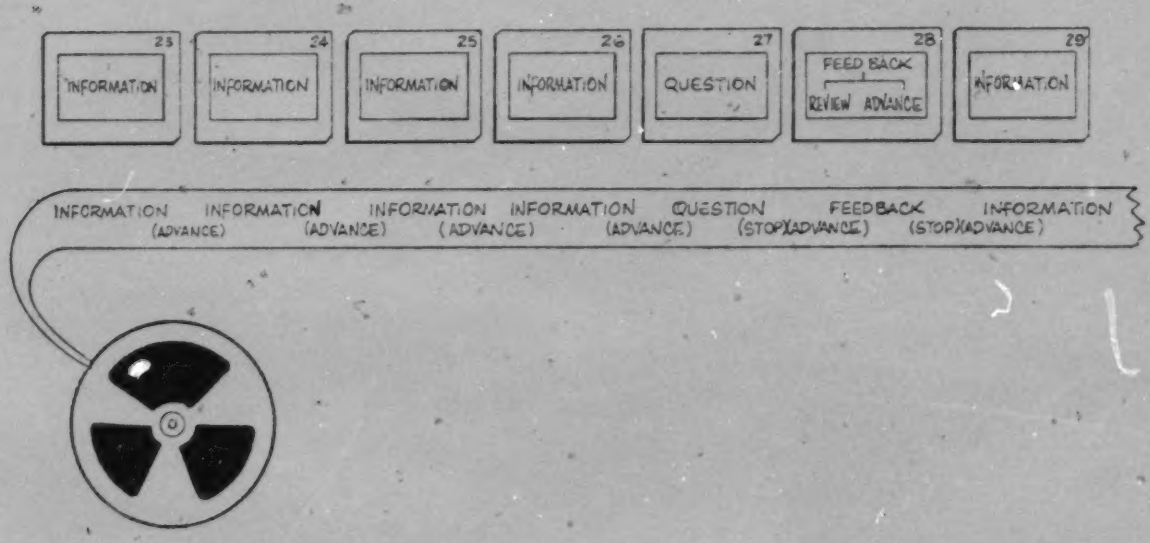


Figure 4. Format of sound-slide presentation format.

One remaining problem was to locate an audio playback unit that would be capable of reversing the slides while keeping the audio tract in synchronization. It was felt that this function was crucial to the success

of the supplemental presentations since a strictly linear type of program with no review capabilities was inconsistent with the philosophy and goals of the project. At the time this decision was being made, the only available audio playback unit with review capabilities was manufactured by Telex Corporation of Minneapolis, Minnesota. Consequently, all supplemental materials were developed around the capabilities of this machine.

An additional piece of equipment, a sophisticated slide production system, was purchased to add professional quality to the thousands of technical slides that were being developed.

These questions and problems having been resolved, a second workshop was organized in June of 1974, to train the twenty institutional instructors in the techniques of writing scripts for the supplemental sound-slide presentations. Each instructor was asked to pick one of the problem areas identified in the walk-through, to develop an objective for a sound-slide presentation, and to write a complete script. As in the modules, the material presented in the sound-slide presentations was introduced in small steps followed by a practice problem with immediate feedback.

Following the workshop, instructors were contracted to continue the script development. As with the modules, they were once again responsible for one edit of their scripts following a consultant's review. Remuneration was based on the recorded time of the script. A general rule of thumb was established to hold the length of each script to no more than twenty minutes; however, the principal criteria for length was the amount of explanation required to completely cover an objective.

As of mid-August, more than one hundred sound-slide presentations were in various stages of development. The overall goal of the project staff

was to complete at least two hundred slide presentations before the termination of the project.

PROJECT EVALUATION

Simultaneously with sound-slide presentation and module development, the project staff was actively engaged in a complete evaluation of all the instructional material. To fulfill this objective, a Research Associate, with a strong background in testing and measurement, was hired in June 1975.

A third workshop for the consortium faculty members was held shortly after the Research Associate arrived in order to introduce the participating instructors to the evaluation plan and to develop the strategy for implementing the evaluation. The evaluation strategy and results are presented in the final section.

EVALUATION OF THE INDIVIDUALLY-PACED INSTRUCTIONAL FORMAT[1]

Introduction

The purpose of the National Science Foundation (NSF) grant was to develop an individually-paced instructional format for a state-wide Civil Engineering Technology curriculum in South Carolina. In the past three years, approximately 160 competencies were identified for eleven core courses in the civil engineering program. The basic format for each course was a combination of written modules forming a linear progression through a series of related objectives. In some cases the written material was broadened by a series of media presentations for students having difficulty

[1] Consulting services were provided by Dr. Garrett K. Mandeville and Dr. Lorin W. Anderson of the University of South Carolina. The project staff, however, assumes full responsibility for the final interpretation of the results.

understanding particular concepts presented in the modules.

In an effort to determine the effectiveness of the materials developed, a state-wide evaluation was conducted during the fall, winter, and spring quarters of the 1975-1976 academic year. The evaluation basically utilized a pretest/posttest design to compare students taught by an individually-paced instructional format to students taught by a more conventional lecture-based approach.

A listing of evaluation problem statements includes the following:

1. Do students learn more under the individually-paced curriculum than under more conventional teaching methods?

2. An individually-paced curriculum may produce a very different grade distribution than that observed in a lecture-based course since more students may receive higher grades in an individually-paced curriculum. Are these higher grades justified?

3. Do individually-paced students exhibit a significantly different long-term retention of facts and concepts than students taught by a lecture method?

4. Can individually-paced curriculum materials developed by a given instructor be used in another institution with roughly equivalent results? That is, are well-written individually-paced curriculum courses relatively independent of the actual instructor, provided the instructor using them understands how the individually-paced curriculum works?

5. The majority of people who have taught self-paced courses have experienced the "procrastination" problem evidenced by a significant number of students who progress through a course at a rate much slower than average. What are the various causes of procrastination and how may a course be designed to minimize the problem?

6. Do students under an individually-paced curriculum display a more positive affect toward subject matter than students under more conventional teaching methods?

Definitions of Experimental and Control Strategies

As mentioned in the Introduction, two instructional strategies were

utilized in the evaluation: the individually-paced method and the lecture-based method. These teaching strategies will be referred to as the experimental and control strategies, respectively. A brief introduction to these instructional formats is outlined below.[1]

(1) Individually-Paced Method of Instruction (Experimental)

The individually-paced curriculum is similar to Keller's Personalized System of Instruction (PSI) in that it focuses on individual learning based on small units of instruction. These units of instruction are in the form of modules which are usually completed by the student in a week's time or less. Like PSI, this method of instruction is individual-oriented rather than group-oriented. However, there are essential differences between the Keller plan and the individually-paced curriculum. Some of these differences are: (1) students move through the modules (learning units) at a prespecified pace; (2) a demonstration of mastery (80%-95%) is required at the end of each module before the student is permitted to continue into the next module (however, these module post-tests do not count toward the student's final grade); (3) slide-tape presentations and other alternative (non-reading) learning methods are available for individual use within each module; and, (4) the student's final grade is determined primarily by his performance on a final exam (instructors

1 The distinctive features of the individually-paced and lecture-based instructional methods as well as the responsibilities assigned to instructors may be seen in Tables 13-15 (Appendix A).

had the option of using a mid-term as well).

(2) Lecture-Based Instructional Method (Control)

One of the most common types of instructional strategies, lecture-based instruction, is basically textbook oriented. The instructor plays the vital role of lecturing on key ideas and concepts specified by the course objectives. The lecture-based method is a group-based strategy where the time allowed for learning is relatively fixed. The course is divided into larger learning units and the student is given a test at the end of each unit which counts toward his final grade. Therefore, the student's grade is determined by his performance on the unit tests (numbering between two and four in most cases) as well as his performance on the final exam.

Although these instructional strategies were purposely contrasted, the evaluation procedures should not favor one strategy over the other. All of the testing instruments used to measure student performance were based on prespecified course objectives developed by the instructors on the NSF grant. With the exception of one out-of-state instructor, all of the instructors were quite familiar with the objectives of each course.[1] In viewing the distinctive features of the instructional strategies (Tables 14 and 15), all instructors had copies of the modules and objectives contained with each course. Aside from the characteristics noted above, the instructional strategies differed on one important point: the individually-paced method utilized

1 The out-of-state instructor taught civil engineering courses at a two-year community college in North Carolina. This community college was used in attempting to answer Problem Statement 4.

the instructor as a manager of student learning, whereas the lecture-based method enabled the instructor to become the main dispenser of information. The objectives were already stated and in written format (i.e., in modular form) for the individually-paced approach, whereas the dissemination of objectives and written format was primarily the responsibility of the instructor in the lecture-based approach. In essence, both instructional strategies were designed to emphasize student learning with respect to the same course objectives. A basic difference between the instructional strategies was the way in which these objectives were approached.

Data Source

The sample consisted of 250 male students enrolled in two-year, post high school engineering technology programs. Of this total, 220 students were located in seven technical education colleges throughout the state of South Carolina, and 30 students were located in one community college in North Carolina. In all of the two-year institutions, the majority of students ranged from eighteen to twenty-two years of age (65%), were non-veterans (70%), and were enrolled in a civil engineering program (65%). Those students not enrolled in civil engineering programs (35%) were enrolled in related engineering fields (e.g., engineering technology, architecture, building construction, and engineering graphics).

Assignment to Groups

Instructors were allowed to choose the instructional format (individually-paced or lecture-based method) they preferred. This procedure for assigning instructors to treatment groups presents a possible methodological problem: a self-selection of teachers into treatment

groups that is probably not random. While random assignment of teachers to treatment groups may be construed as a methodological ideal, true randomization and experimental design in a school setting are nearly impossible to attain from a practical viewpoint. Given the diverse nature of the two instructional formats, the instructors would have likely chosen the teaching method with which they were most comfortable and presumably, most likely to be successful. In essence, allowing instructors to select teaching method was viewed as a strength, not a weakness, of the evaluation.

Description of Measuring Instruments Used[1]

Listed below are the types of instruments used in the evaluation. The order in which these instruments were administered may be found in Tables 1 and 2.

(1) Career Planning Profile

The CPP, a product of the American College Testing Program (ACT), contains eight "ability measures," three of which were selected to be administered in a forty-five minute time period.[2] The three ability measures used were Reading Skills, Mathematical Usage, and Nonverbal Reasoning. Reading Skills was designed to measure the ability to read and understand factual material as well as more subtle aspects of comprehension. The

1 With the exception of the Career Planning Profile (CPP), the measuring instruments used may be seen in Appendix B.

2 This particular adaptation of the CPP was made possible through the joint efforts of John D. Roth (Director of Career Planning, ACT) and C. A. Edwards (Senior Coordinator for Student Services, SBTCE). The subtests were measured in terms of raw scores (reading = 40 items; math = 20 items; and nonverbal reasoning = 35 items).

Mathematical Usage scale was designed to measure the ability to apply arithmetic operations to the solution of practical reasoning problems. The section of Nonverbal Reasoning was intended to measure abstract reasoning ability without reference to verbal material. Based on descriptive data provided by ACT, the scales of Reading Skills, Mathematical Usage, and Nonverbal Reasoning had reliability estimates (Kuder-Richardson Formula 20) of 0.86, 0.83, and 0.88, respectively, based on a sample of N = 92.

(2) Summative Tests

A fifty-item, multiple-choice test was constructed for each of the ten courses evaluated in the Civil Engineering Technology program. Each summative test was constructed from a crude table of specifications tapping the content covered and behavior level required.[1] Of the total number of items on each summative test, approximately 40% were classified as knowledge items and 60% as comprehension items.

The items reflect some of the test format proposed by the National Council of Engineering Examiners (NCEE) in 1975.[2]

[1] A rating scale was devised to determine the essential course content needed to be covered and completed by the "average" student within an eleven week quarter. Instructors were asked to rate each of the course objectives with one of three alternatives: "crucial," "useful but not essential," or "not important." The behavior level of an item was classified as either "knowledge" or "comprehension." Knowledge items were stated in a form similar to that in which the content was taught. Comprehension items were stated in forms at higher levels than knowledge items; that is, comprehension items included the levels of comprehension, application, and analysis described in Bloom's taxonomy (Bloom, B.S. Taxonomy of Educational Objectives: Cognitive Domain. David McKay Company, Inc. New York. 1965.).

[2] This information was provided by George E. Sutton, Director of Professional Services (NCEE).

In addition to having only one correct answer, the remaining distractors appear to be rational answers to a student if a normal error in formula, mathematics or interchange of engineering units is made. Also, all items were independent even though it might appear that an answer to one item was dependent on answering another correctly.

A summative test was administered to students as a pretest and as a posttest in each particular course. An accompanying "formula sheet" could be used by students in answering the items. Calculators or slide rules were also permissible. A two-hour time limit was placed on each summative test.

(3) Course Evaluation

A fifty-item Likert scale (ranging from "strongly disagree" to "strongly agree") was administered to students after receiving the Summative Posttest. The Course Evaluation consisted of eight subscales that were logically validated (Table 9). The Course Evaluation was further validated empirically through the use of a factor analysis technique which revealed four subscales pertinent to the evaluation: (1) "Course Workload and Grading," (2) "Instructor Effectiveness," (3) "Attitude Toward Course and Instructional Method," and (4) "Relevancy of Course and Instructional Method."

(4) Course Questionnaire

This questionnaire was sent to all students who dropped a course, received an incomplete, or failed a course. The Course Questionnaire had three sections: (1) "General Information,"

(2) "Course Evaluation," and (3) "Course Comments." The section entitled "Course Evaluation" contained the same items as the Course Evaluation administered to those students completing the course.

(5) Evaluative Posttest Information Sheet

Each student taught by the individually-paced instructional format was required to fill out a ten-item Likert scale (ranging from "strongly disagree" to strongly agree") before taking a module pretest or posttest. Although not directly tied to the evaluation problem statements, the Evaluative Posttest Information Sheet was deemed necessary to check on the adequacy of the modules and the media presentations (slide-tape presentations) where appropriate.

(6) Instructor Questionnaire

Each instructor was required to complete an open-ended questionnaire after teaching a course. The instructor was requested to identify the three major advantages and disadvantages of the particular instructional format (individually-paced or lecture-based) used. The instructor was also requested to rate the appropriateness of the summative test and of the instructional method to the course.

Design of the Analysis

A one-way analysis of variance design was the basic strategy for analyzing the results of the evaluation. The design includes the effect

due to treatment (experimental vs. control groups). The model for the analysis was:

$Y = \mu + T + E$, where

Y = the dependent variable,

μ = the grand mean,

T = the treatment effect, and

E = random error.

The treatment effect was tested by comparing the mean square due to treatment against the mean square due to random error.

Limitations of the Study

The design of the analysis appears to utilize a rather simplistic model given the relative complexity of the evaluation problem statements. In addition to the effect due to treatment, a more appealing analysis would have been to include campus as a factor as well as classes nested in campus and subjects nested in classes. Interaction effects such as treatment by campus would also have been appropriate in a more sophisticated analysis of variance design.

The main deterrent to using a more sophisticated design was the limited number of classes evaluated in each course. In some instances, only a single class in one course was evaluated; in other cases, there were four or five classes evaluated per course. The lack of appropriate numbers of classes was primarily due to the fact that course materials were not sufficiently developed in time to evaluate them. In some cases, classes were rescheduled or carcelled; in other cases, classes were eliminated because instructors were not implementing the instructional

strategies as they were operationally defined. The small number of classes per course, therefore, eliminated the possibility of incorporating analysis of variance design models using such terms as classes nested in campus and treatment by classes nested in campus interaction. The evaluation might have been more profitable had fewer courses with a larger number of classes been investigated. Nevertheless, all of the courses sufficiently developed during the evaluation were analyzed.

Results

This section deals primarily with the analysis of the six evaluation problem statements cited in the Introduction. Appropriate tables are placed at the end of each problem statement to preserve reading continuity. At the end of the Results section, the findings from the Evaluative Posttest Information Sheet are given. These findings attempt to lend some insight concerning the adequacy of the modules and the media presentations (slide-tape presentations) for the individually-paced classes.

Problem Statement 1

Do students learn more under the individually-paced curriculum than under more conventional teaching methods?

In an effort to resolve this issue, cognitive achievement in ten civil engineering technology courses was analyzed with respect to two operationally defined instructional strategies: an individually-paced method and a lecture-based method. For each particular course, a fifty-item summative test was administered to students both as a pretest and as a posttest. In addition to the summative tests, students were also required to take three subtests

(Reading Skills, Mathematical Usage and Nonverbal Reasoning) of the Career Planning Profile (CPP).

The CPP subtests and the Summative Pretest were administered in each course to assess student entry behaviors.[1] Results of these measures may be found in Tables 1 and 2. Table 1 displays the Pearson product-moment correlations of the CPP subtests and the Summative Pretest with the Summative Posttest by instructional method (individually-paced vs. lecture-based) in each of the ten civil engineering technology courses. In essence, Table 1 shows the relationship between student entry behaviors and student exit behaviors. The results portrayed in Table 1 were sporadic: the correlations ranged from -0.87 to +0.70. With approximately half of all the correlation coefficients falling within a range of ±0.30, relatively few significant correlations were found. These sporadic results may have been due, in part, to the low numbers of students in both experimental and control groups within particular courses.

Despite the sporadic results observed in Table 1, an attempt was made to see whether student entering behaviors in particular courses were significantly different with respect to treatment (e.g., experimental vs. control). With treatment as the main effect, one-way analyses of variance were performed using the Summative Pretest and two of the CPP subtests (Reading Skills and Mathematical Usage) as dependent variables in each of

1 In this context, student entry behaviors are defined as the aptitude and/or achievement measures students possess prior to instruction (or, in this instance, prior to taking a particular course). Student exit behaviors, on the other hand, are defined as those measures students possess after receiving instruction. Student entry behaviors were assessed because students were not randomly assigned to experimental and control classes.

the ten civil engineering technology courses.[1] Results in Table 2 indicate that there were no statistically significant differences found (with the exception of the math subtest in Structural Steel) between the experimental and control groups on the reading and math subtests. On the other hand, there were statistically significant differences observed between the two groups on the Summative Pretests in four of the five courses analyzed. Statistically significant differences favoring the control group were found in the following three courses: Highway Design and Construction, Surveying I and Structural Steel.[2] In summary, the student entering behaviors measured did not appear to favor the experimental group. In terms of the reading and math subtests of the CPP, the two groups were relatively equal; in terms of the Summative Pretest, the control group maintained a slight advantage.

Student exit behaviors, as measured by the Summative Posttest in each course, were analyzed in the same manner as the student entry behaviors.[3]

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[1] The CPP Nonverbal Reasoning subtest was not included in the analysis for two reasons. First of all, this subtest was negatively correlated to more of the Summative Posttests than were the reading and math measures. In addition, only one of the correlations was found to be statistically significant. The reader should also note that comparisions between experimental and control groups could only be made in six of the ten courses using the reading or math subtests as dependent variables and in only five courses using the Summative Pretest as the dependent variable.

[2] The reader should note that the mean of the experimental group in Structural Steel ($\bar{X}_E = 8.2 < \bar{X}_C = 13.7$) and the mean of the control group in Structural Concrete ($\bar{X}_C = 7.4 < \bar{X}_E = 20.6$) were quite low. By chance alone, a student should be able to guess correctly on twelve to thirteen items on a fifty item test with four alternatives per item. The low means noted possibly indicates that students were not really trying on these particular Summative Pretests.

[3] The reader may question analyzing the Summative Posttests without using some or all of the student entry behaviors as covariates. Although one of the uses of analysis of covariance is to increase precision, the results in Table 1 indicate that neither the CPP subtests nor the Summative Pretest were correlated consistently high enough with the Summative Posttest to be used as covariates.

One-way analysis of variance results using treatment (experimental vs. control) as the main effect may be observed in Table 2. Due to an absence of an experimental group or a control group, only six of the ten courses could be analyzed in this fashion.[1] Statistically significant differences favoring the experimental group were found in three of the six courses: Highway Design and Construction, Structural Steel and Structural Concrete. In the case of the first two courses mentioned, statistically significant differences favoring the control group were found on the Summative Pretest; in the case of Structural Concrete, statistically significant differences favored the experimental group on the Summative Pretest. Although not statistically significant, differences in favor of the experimental group were also found in the Surveying I and Surveying II Summative Posttests.[2] Differences favoring the control group were found in only one course, Hydraulics, although this difference was not statistically significant. In terms of student entry and exit behaviors, then, the individually-paced students appear to have made more cognitive gains than those students taught by the lectured-based method of instruction.

As an interesting sidelight, the results of the Summative Pretest and Summative Posttest are also presented in Table 3. This table includes the

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1 Four of the courses contained only an experimental or control group. Of these four courses, three were individually-paced. The experimental groups in Statics, Cost Estimating and Soil Mechanics made Summative Pretest/Summative Posttest mean gains of 16.1, 11.6 and 11.0 raw score points. In the one course using the lecture-based method (Strength of Materials), the Summative Pretest/Summative Posttest mean gain of the control group was 3.4 raw score points.

2 In the case of Surveying I, statistically significant differences in favor of the control group were found on the Summative Pretest. No significant differences were observed on the Surveying II Summative Pretest.

means, standard deviations and raw score ranges of the experimental and control groups in the ten civil engineering technology courses evaluated. Based on Bloom's (in press) thinking concerning individual differences, one would expect that the variation of scores on the Summative Posttests would be much less for individually-paced students (where "mastery" was required) than for lecture-based students.[1] With the exception of Surveying II, Hydraulics, and Structural Concrete, however, just the opposite was true: the standard deviations and raw score ranges of the Summative Posttests were slightly larger in individually-paced courses than in lecture-based courses. In essence, there appeared to be as much variability among individually-paced students as there was with lecture-based students in terms of student exit behaviors. This increased variability may be, in part, attributed to the emphasis placed on individual learning rather than on group learning.

1 Bloom, B.S. Human Characteristics and School Learning. New York: McGraw-Hill (in press).

Table 1. Pearson product-moment correlations of summative pretest, CPP subtests (reading, math, and nonverbal) with summative posttest in ten civil engineering technology courses.

	Summative Pretest		CPP Reading		CPP Math		CPP Nonverbal	
COURSE	r_C	r_E	r_C	r_E	r_C	r_E	r_C	r_E
Highway Design and Construction	-0.38 (11)	0.03 (33)	-0.13 (8)	0.22 (23)	0.26 (8)	0.30 (23)	-0.23 (8)	0.03 (23)
Surveying II	0.52* (16)	0.20 (8)	0.47 (15)	0.44 (12)	0.22 (15)	0.52 (12)	0.38 (15)	0.45 (12)
Statics	-	0.38** (47)	-	0.13 (40)	-	0.29 (40)	-	0.08 (39)
Surveying I	0.50 (13)	0.32 (19)	0.63* (12)	0.70** (26)	0.51 (12)	0.50** (26)	-0.24 (12)	0.58** (26)
Structural Steel	0.08 (31)	-0.42** (39)	0.26 (28)	0.31 (32)	0.33 (28)	0.43** (32)	0.30 (28)	0.32 (31)
Strength of Materials	-0.16 (7)	-	0.09 (6)	-	-0.87* (6)	-	-0.04 (5)	-
Hydraulics	-	-	0.44 (12)	0.42 (9)	0.13 (12)	0.50 (9)	0.27 (12)	0.59 (9)
Cost Estimating	-	0.10 (14)	-	0.18 (10)	-	0.07 (10)	-	-0.03 (10)
Structural Concrete	-0.53** (21)	0.35 (14)	-0.18 (13)	0.09 (13)	0.59* (13)	0.27 (13)	0.33 (13)	0.26 (13)
Soil Mechanics	-	-0.19 (10)	-	0.12 (8)	-	0.25 (8)	-	-0.27 (8)

NOTE:

r_C = product-moment correlation in control group

r_E = product-moment correlation in experimental group

Asterisks indicate degree of significance: * ($P < .05$), ** ($P < .01$)

Table 2. Analysis of variance results for summative posttests, pretests and CPP subtests (reading and math) in ten civil engineering technology courses.

	Summative Posttest				Summative Pretest				CPP Reading				CPP Math			
COURSE	$\bar{X}_C$	$\bar{X}_E$	F(df)	P	$\bar{X}_C$	$\bar{X}_E$	F(df)	P	$\bar{X}_C$	$\bar{X}_E$	F(df)	P	$\bar{X}_C$	$\bar{X}_E$	F(df)	P
Highway Design and Construction	24.9 (10)	35.5 (33)	33.46 (1,39)	<.01	22.1 (11)	18.7 (33)	6.71 (1,40)	<.01	29.5 (8)	31.2 (23)	0.86 (1,27)	N.S.	9.5 (8)	11.1 (23)	1.06 (1,27)	N.S.
Surveying II	37.5 (16)	39.1 (15)	0.89 (1,29)	N.S.	23.3 (16)	23.9 (8)	0.07 (1,22)	N.S.	31.7 (15)	29.8 (12)	1.09 (1,25)	N.S.	11.7 (15)	9.7 (12)	2.56 (1,25)	N.S.
Statics	-	34.0 (51)	-		-	17.9 (47)	-		-	29.4 (40)	-		-	10.7 (40)	-	
Surveying I	29.4 (14)	31.1 (28)	0.64 (1,39)	N.S.	20.4 (13)	17.1 (19)	6.93 (1,29)	<.05	32.3 (12)	29.0 (26)	2.39 (1,35)	N.S.	10.2 (12)	9.1 (26)	0.69 (1,35)	N.S.
Structural Steel	22.0 (30)	27.4 (38)	20.3 (1,61)	<.01	13.7 (31)	8.2 (39)	71.6 (1,63)	<.01	31.3 (28)	31.4 (32)	0.02 (1,53)	N.S.	10.4 (28)	12.3 (32)	4.61 (1,53)	<.05
Strength of Materials	19.7 (7)	-	-		16.3 (7)	-	-		32.3 (6)	-	-		13.0 (6)	-	-	
Hydraulics	32.1 (13)	30.5 (22)	0.72 (1,33)	N.S.	-	-	-		32.7 (12)	30.0 (9)	1.58 (1,19)	N.S.	12.4 (12)	14.2 (9)	1.50 (1,19)	N.S.
Cost Estimating	-	33.6 (14)	-		-	22.0 (14)	-		-	32.1 (10)	-		-	12.4 (10)	-	
Structural Concrete	22.2 (21)	35.4 (14)	95.03 (1,32)	<.01	7.4 (21)	20.6 (14)	125.23 (1,32)	<.01	30.6 (13)	33.4 (13)	2.59 (1,23)	N.S.	12.2 (13)	10.6 (13)	1.33 (1,23)	N.S.
Soil Mechanics	-	27.3 (10)	-		-	16.3 (10)	-		-	32.1 (8)	-		-	9.9 (8)	-	

NOTE:
$\bar{X}_C$ = mean of control group
$\bar{X}_E$ = mean of experimental group

Table 3. Descriptive statistics for summative pretests and summative posttests in ten civil engineering technology courses.

COURSE	Treatment Group	Summative Pretest Mean and Standard Deviation	Summative Posttest Mean and Standard Deviation	Raw Score Range	
				Pretest	Posttest
Highway Design and Construction	Control	22.1 (4.0)	24.9 (3.3)	15-27	16-27
	Experimental	18.7 (4.3)	35.5 (5.9)	9-25	21-43
Surveying II	Control	23.3 (5.0)	37.5 (5.7)	17-31	25-45
	Experimental	23.9 (5.2)	39.1 (3.7)	17-30	35-47
Statics	Control	-	-	-	-
	Experimental	17.9 (4.7)	34.0 (7.4)	9-28	18-46
Surveying I	Control	20.4 (2.9)	29.4 (4.6)	15-24	19-36
	Experimental	17.1 (3.9)	31.1 (7.3)	12-24	14-43
Structural Steel	Control	13.7 (2.9)	22.0 (6.0)	7-20	14-33
	Experimental	8.2 (5.7)	27.4 (7.0)	0-18	14-43
Strength of Materials	Control	16.3 (5.9)	19.7 (7.8)	9-24	7-28
	Experimental	-	-	-	-
Hydraulics	Control	-	32.1 (5.5)	-	26-41
	Experimental	-	30.5 (5.2)	-	21-41
Cost Estimating	Control	-	-	-	-
	Experimental	22.0 (3.9)	33.6 (4.9)	15-27	20-40
Structural Concrete	Control	7.4 (8.0)	22.2 (4.5)	0-23	15-32
	Experimental	20.6 (3.7)	35.4 (4.4)	15-27	28-43
Soil Mechanics	Control	-	-	-	-
	Experimental	16.3 (3.3)	27.3 (3.0)	11-21	24-32

NOTE:

The "Raw Score Range" denotes the lowest and highest score (number of items correct) recorded on each fifty (50) item summative pretest and summative posttest.

Problem Statement 2

An individually-paced curriculum may produce a very different grade distribution than that seen in a conventional course, as many more students may receive A's and B's in an individually-paced curriculum. Are these higher grades justified?

Instructors were required to make available the final letter grades they assigned to their students in the spring quarter. Structural Concrete was the only course analyzed because of the limited number of classes in the other spring courses. In Structural Concrete, there were two control classes of eight and twelve students, and one experimental class of fourteen students. The results observed in this section should be interpreted with caution due to the fact that only one course with a limited number of classes was analyzed.

A one-way analysis of variance was used to analyze the results. Table 4 indicates there were no significant differences between experimental and control groups with respect to final grades assigned. In fact, final grades were slightly higher for the control classes ($\overline{X}_C = 3.3$) than for the experimental class ($\overline{X}_E = 3.2$)

The grade distribution for the experimental and control classes reveals the following information:

Grade Distribution Percentages

	A	B	C	D	F
Experimental (N = 14)	36%	50%	14%	-	-
Control (N = 20)	45%	35%	15%	5%	-

In both the experimental and control classes, the majority of students received "A's" or "B's" (86% in the experimental group vs. 80% in the control group). A chi-square value of 0.19 was obtained by comparing the proportion of "A's" and "B's" to the proportion of "C's" and "D's" in the experimental and control groups. With one degree of freedom, this chi-square value was not significant. In the case of Structural Concrete, there appears to be no dependent relationship between grades assigned and instructional method used.

The last portion of the problem statement deals with the question of whether higher grades in an individually-paced curriculum are justified. This question would have been applicable if there had been differences observed in the means of the final grades assigned in the experimental and control groups; however, there were no significant differences observed. If differences in grades had been observed, the problem of justification might have been demonstrated by using analysis of covariance (ANCOVA) with the Summative Posttest as a covariate and, hopefully, achieving non-significance (with the assumption that Summative Posttest differences observed would be "adjusted for" in the ANCOVA).

Table 4. Analysis of variance results for final grades assigned in Structural Concrete.

	Final Grades Assigned			
Course	$\bar{X}_C$	$\bar{X}_E$	$F_{(df)}$	P
Structural Concrete	3.3 (20)	3.2 (14)	0.02 (1,31)	N.S.

NOTE:

X_C = mean of control group

X_E = mean of experimental group

Grades were determined by the following scoring scheme: A=4, B=3, C=2, D=1, F=0

Problem Statement 3

Do individually-paced students exhibit a significantly different long-term retention of facts and concepts than students taught by a lecture method?

Ten weeks after a Summative Posttest in Structural Steel had been administered, a twenty-item Retention Test was given to twenty-five students taught by the lecture-based method and to twelve students taught by the individually-paced method. The Retention Test was considerably shorter than the Summative Posttest so that it could be administered in a one hour time period.[1]

From the results observed in Problem Statement 1, students in individually-paced classes significantly outperformed students in lecture-based classes on the Structural Steel Summative Posttest. This same level of significance is also observed in Table 5 , where the means of the Summative Posttest in Structural Steel are based on twenty items rather than on fifty items.[2]

One-way analysis of variance results using treatment (experimental vs. control) as the main effect may be observed in Table 5 . Although the results were not significantly different (P = 0.07), the experimental group scored higher than the control group on the Retention Test

[1] The Retention Test was merely a shortened version of the Structural Steel Summative Posttest. Twenty items were selected by an instructor who had taught the Structural Steel course by the lecture-based method. As in the Summative Posttest, 40% of the retention items were classified as knowledge items and 60% were classified as comprehension items.

[2] Two points need to be emphasized. First of all, only the twenty "common" items included on both the Retention Test and the Summative Posttest in Structural Steel were used in the analysis. Secondly, the reader will note there were fewer students (N = 38) receiving the Retention Test than there were students (N = 68) receiving the Summative Posttest. The loss of students was primarily due to administrative difficulties.

($\bar{X}_E = 9.9 > \bar{X}_C = 7.9$); however, the question of initial performance on the Summative Posttest must be resolved.

Two methods of analysis were used to investigate "retention" in terms of the initial performance on the Summative Posttest. The first method involved analysis of the experimental and control groups in terms of "pure retention." A "Difference Score," calculated by subtracting the mean of the Retention Test from the mean of the Summative Posttest, is presented in Table 5 . In terms of "pure retention," the experimental students appear to have lost more than the control students in the absolute sense ($\bar{X}_E = 4.2 > \bar{X}_C = 1.7$) although the experimental students scored higher overall on the Retention Test. The second method regressed the Retention Test scores onto the Summative Posttest scores for the control group. Prediction of the Retention Test score for the experimental group was obtained and compared to the actual Retention Test score.[1] A one-tailed t-test ($t = 0.57$) revealed that the difference between the actual value and the predicted value of the Retention Test score for the experimental group was not significantly different from zero.[2]

One final method was used to analyze the Retention Test results. Table 6 reveals chi-square results for each of the Structural Steel

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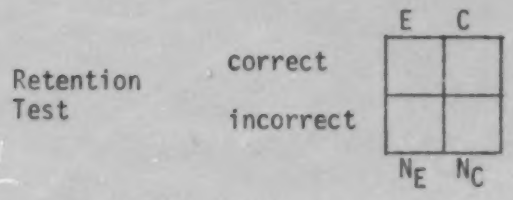
1 The predicted Retention Test score of the experimental group was obtained from the following regression equation: $Y = 3.57 + 4.18$ (Posttest Score). The predicted Retention Test score of the experimental group ($Y = 9.46$) was then subtracted from the actual Retention Test Score ($\bar{X}_E = 9.92$) observed in Table 5 . A difference of 0.46 was observed between the predicted and actual (observed) Retention Test score for the experimental group.

2 The t-value was calculated as follows:

$$t = \frac{0.46}{2.806/\sqrt{12}} = 0.57$$

retention items. In accordance with the two methods of analysis used above, initial differences in Summative Posttest performance were taken into account by analyzing only those students who got a specific item correct on the Summative Posttest. A 2 X 2 contingency table of the following form appeared appropriate in analyzing the twenty Retention Test items:



where N_E and N_C are the number of students in the experimental and control groups who answered the item correctly on the Summative Posttest.

To observe whether item retention differed between experimental and control groups, a chi-square analysis was applied to the contingency tables outlined in Table 6 . With the exception of the first two items, the values of chi-square were not found to be significant at the 0.05 level in testing for differences in the proportions of items correct on the retention test for the two instructional methods. In essence, there appears to be no dependent relationship between the amount of item retention and the instructional method utilized.[1]

[1] Although the majority of chi-square values were not found to be significant, Table 6 merits further investigation. The proportions of students answering retention items correctly appear to be slightly in favor of the experimental method. There were only three clear-cut cases in which the control students outperformed the experimental students (i.e., items 10, 13, and 15); on the other hand, there were nine items which favored the experimental students (i.e., items 1, 2, 3, 4, 5, 7, 14, 18, and 20). There appeared to be no "direction" for the eight remaining items.

Table 5 . Analysis of variance results for summative posttests, retention tests, and difference scores in Structural Steel.

	Summative Posttest*				Retention Test				Difference Score**			
COURSE	$\bar{X}_C$	$\bar{X}_E$	$F_{(df)}$	P	$\bar{X}_C$	$\bar{X}_E$	$F_{(df)}$	P	$\bar{X}_C$	$\bar{X}_E$	$F_{(df)}$	P
Structural Steel	9.6 (25)	14.1 (12)	13.01 (1,35)	<.01	7.9 (25)	9.9 (12)	3.44 (1,35)	N.S.	1.7 (25)	4.2 (12)	5.54 (1,35)	<.05

NOTE:

$\bar{X}_C$ = mean of control group

$\bar{X}_E$ = mean of experimental group

* The means of the Summative Posttest in this table are based only on the 20 items used for the Retention Test in Structural Steel.

** The Difference Score is calculated by subtracting the mean of the Retention Test from the mean of the Summative Posttest.

Table 6 . Chi-square results of structural steel retention items.

Item Number	Classification	Treatment Group	Correct Responses	Incorrect Responses	χ^2(1df)	P
1	Comprehension	Control	0	11	13.55	<.01
		Experimental	9	3		
2	Knowledge	Control	2	7	5.40	<.01
		Experimental	5	1		
3	Comprehension	Control	5	11	1.47	N.S.
		Experimental	6	5		
4	Comprehension	Control	19	5	2.67	N.S.
		Experimental	11	0		
5	Comprehension	Control	3	10	1.38	N.S.
		Experimental	3	3		
6	Comprehension	Control	6	3	0.14	N.S.
		Experimental	6	2		
7	Comprehension	Control	4	9	0.50	N.S.
		Experimental	2	2		
8	Comprehension	Control	8	8	0.07	N.S.
		Experimental	4	5		
9	Knowledge	Control	13	6	0.07	N.S.
		Experimental	7	4		
10	Knowledge	Control	2	2	0.90	N.S.
		Experimental	1	4		
11	Comprehension	Control	8	6	0.16	N.S.
		Experimental	4	2		
12	Comprehension	Control	7	8	0.00	N.S.
		Experimental	5	6		
13	Comprehension	Control	9	6	0.21	N.S.
		Experimental	4	4		
14	Comprehension	Control	4	9	2.17	N.S.
		Experimental	4	2		
15	Comprehension	Control	9	3	2.03	N.S.
		Experimental	4	5		
16	Knowledge	Control	0	4	1.56	N.S.
		Experimental	1	2		
17	Knowledge	Control	10	1	1.98	N.S.
		Experimental	8	4		
18	Knowledge	Control	4	5	2.57	N.S.
		Experimental	8	2		
19	Knowledge	Control	11	3	0.68	N.S.
		Experimental	7	4		
20	Knowledge	Control	0	0	insufficient data for χ^2	
		Experimental	3	7		

NOTE:

The number of total responses (correct responses and incorrect responses) within treatment group varies from item to item. This is due to the fact that only students correctly answering items on the summative posttest were analyzed on the respective retention test items.

Problem Statement 4

Can the individually-paced curriculum materials developed by a given instructor be used in another institution with roughly equivalent results? That is, are well-written individually-paced curriculum courses relatively independent of the actual instructor, provided the instructor using them understands how the individually-paced curriculum works?

An attempt was made to answer the above problem in part by using some of the individually-paced materials in an institution outside the state of South Carolina. Sandhills Community College, a two-year institution located in North Carolina, agreed to participate in the evaluation by using the individually-paced instructional method. Two experimental classes, one in Highway Design and Construction and another in Surveying II, were taught during the spring quarter in Sandhill's Civil Engineering Technology program.

The general characteristics of the engineering technology students in Sandhills Community College compared favorably to the technology students enrolled in the South Carolina schools. The majority of Sandhill's engineering technology students ranged in age from eighteen to twenty-two years of age (65%), were non-veterans (75%), and were enrolled in civil engineering programs (65%). Those students not enrolled in civil engineering programs (35%) were enrolled in architectural technology, a related engineering field.

The students enrolled in the two experimental classes at Sandhills were also compared in terms of student entering behaviors to the South Carolina students enrolled in the experimental classes in Highway Design and Construction and Surveying II. Table 7 indicates there were no significant differences observed on the raw scores of the CPP reading and math subtests between the two experimental groups (South Carolina

schools vs. Sandhills Community College) in either the Highway Design and Construction or the Surveying II courses. There appeared to be no distinct differences between the experimental groups in terms of general characteristics and student entering behaviors.

The two experimental groups were compared on the Summative Pretests and Summative Posttests administered in the two courses. One-way analysis of variance results using treatment (experimental: South Carolina vs. Sandhills) as the main effect may be observed in Table 7. The results concerning the Highway Design and Construction course are confounded by the fact that five items (items 51-55) were missing on the Summative Pretest and Summative Posttest administered to the experimental group in North Carolina; therefore, interpretation of these results is suspect.[1]

With respect to the Surveying II course, Table 7 reveals there were no significant differences between the two experimental groups on the summative tests. Both groups appeared to do equally well on the Summative Pretest ($\bar{X}_{E1} = 23.9 \approx \bar{X}_{E2} = 20.9$) and the Summative Posttest ($\bar{X}_{E1} = 39.1 \approx \bar{X}_{E2} = 38.1$) in Surveying II. Although the data is somewhat limited, the results from the Surveying II course tend to support the idea that the individually-paced curriculum could be used effectively elsewhere.

1 Although there were five missing test items for the North Carolina students, they significantly outperformed the South Carolina students on the Summative Pretest; however, the North Carolina students were significantly behind the South Carolina students in terms of the Summative Posttest.

Table 7. Analysis of variance results for summative posttests, pretests and CPP subtests (reading and math) in two civil engineering technology courses.

	Summative Posttest				Summative Pretest				CPP Reading				CPP Math			
COURSE	$\bar{X}_{E1}$	$\bar{X}_{E2}$	$F_{(df)}$	P	$\bar{X}_{E1}$	$\bar{X}_{E2}$	$F_{(df)}$	P	$\bar{X}_{E1}$	$\bar{X}_{E2}$	$F_{(df)}$	P	$\bar{X}_{E1}$	$\bar{X}_{E2}$	$F_{(df)}$	P
Highway Design * and Construction	35.5 (33)	31.0 (11)	5.84 (1,40)	<.05	18.7 (33)	23.0 (11)	11.1 (1,40)	<.01	31.2 (23)	28.8 (10)	1.90 (1,29)	N.S.	11.1 (23)	10.5 (10)	0.15 (1,29)	N.S.
Surveying II	39.1 (15)	38.9 (14)	0.04 (1,27)	N.S.	23.9 (8)	20.9 (10)	0.71 (1,16)	N.S.	29.8 (12)	27.0 (11)	1.46 (1,21)	N.S.	9.7 (12)	9.7 (11)	0.00 (1,21)	N.S.

NOTE:

$\bar{X}_{E1}$ = mean of experimental group in South Carolina

$\bar{X}_{E2}$ = mean of experimental group in North Carolina (Sandhills Community College)

* Five items were missing on the summative pretest and posttest administered to the experimental group in North Carolina which may account for some of the differences noted.

Problem Statement 5

The majority of people who have taught self-paced courses have experienced the "procrastination" problem evidenced by a significant number of students who progress through a course at a rate much slower than average. What are the various causes of procrastination and how may a course be designed to minimize the problem?

Two instruments were used in attempting to answer the problem statement: the Course Questionnaire and the Instructor Questionnaire.

As noted in the problem statement, a procrastinator is defined as a student who progresses through a course at a rate much slower than average. In an effort to identify procrastinators in both individually-paced and lecture-based groups, the definition of procrastinator was expanded to include any student who dropped a course, received an incomplete, or failed a course.

Of the total number of students identified as procrastinators in the fall, winter, and spring quarters (N = 53), 58% responded to the Course Questionnaire. The general characteristics of those responding to the Course Questionnaire compared favorably to the total sample of 250 students: the majority of procrastinators ranged from eighteen to twenty-two years of age (62%), were non-veterans (70%), and were enrolled in a civil engineering program (75%).

To observe whether the rate of procrastination differed between the two instructional methodologies employed, a chi-square analysis was applied to the contingency tables in Table 8 . The values of chi-square were not found to be significant at the 0.05 level in testing for independence of procrastination and instructional method. A chi-square value of 1.36 was observed for the classification of procrastinators (e.g., students dropping a course, receiving an incomplete, or failing a

course) and students passing a course versus instructional method. A chi-square value of 0.50 was observed for the classification of students dropping and students passing a course versus instructional method. Therefore, there appears to be no dependent relationship between the amount of procrastination and the type of instructional method utilized. There was no observed tendency for students to procrastinate more in individually-paced courses than in lecture-based courses. However, one should be reminded that the individually-paced approach was not totally self-paced; that is, students were given guidelines to move through the modules (learning units) at a prespecified pace. Also, students in the experimental group were required to take the final exam (Summative Post-test) at the end of the quarter and were sometimes required to take a midterm; therefore, the requirements of the individually-paced instructional method may have deterred procrastination evident in many self-paced instructional approaches.

The section entitled "Course Evaluation" in the Course Questionnaire was not utilized in the evaluation. This was due to the small number of procrastinator returns per individual course. However, the open-ended "Course Comments" section was content analyzed with respect to procrastinators in the individually-paced courses. Procrastinators listed the three "major limitations" of the individually-paced format as being:

(1) too many students per class with only one instructor;
(2) too much reliance on modules (learning units) for learning; and,
(3) students must be self-motivated.

Procrastinators listed the three most common methods for "improving instruction" in the individually-paced format as being:

(1) decrease the instructor-student ratio (e.g., limit class size);
(2) introduce one lecture per week for review purposes; and,
(3) prepare a schedule ("time table") for the completion of each module; enforcement of this schedule will help motivate students to complete a course.

The procrastinators in individually-paced courses appeared to be asking for more instructor input as well as for a more rigidly defined course time-table.

Instructors were asked on the Instructor Questionnaire to list the three major advantages and disadvantages of the particular instructional format (individually-paced or lecture-based) used. Listed below are the three major advantages and disadvantages for the two types of instruction.

(1) Individually-Paced Method

A. Advantages:

1. Students may progress at a pace consistent with their abilities.
2. A student may be recycled until acceptable mastery of individual learning objectives is attained.
3. The student is primarily responsible for learning.

B. Disadvantages:

1. The instructor-student dialogue (interaction) is impaired.
2. There are larger demands upon instructor time (dependent directly on the instructor-student ratio).
3. Students have a tendency to procrastinate and fall behind schedule.

(2) Lecture-Based Method

A. Advantages:

1. The instructor has control over the class as a group.
2. Classroom discussion and instructor-student interaction is enhanced.
3. The instructor's time is effectively utilized.

B. Disadvantages:

1. The instructional method is geared toward the average and below average student; coverage of the materials is limited for the best students.
2. A student must take regularly scheduled exams regardless of his degree of achievement.
3. Many students do not become actively involved in the learning process.

Generally speaking, instructors using the individually-paced strategy stressed the importance of that method in terms of student ability and motivation. Instructors utilizing the experimental method emphasized not only that learning was primarily the responsibility of the student, but also that learning should take place in the framework of the student's ability. Viewing the disadvantages of the experimental method, the instructor-student ratio appears to be a critical feature. If the instructor-student ratio is reasonable, the disadvantages of the individually-paced method appear to be minimal.[1]

Instructors using the lecture-based method appeared to emphasize the importance of the class as a group. The instructors using the control method stressed the importance of class control as well as class discussion. These instructors also felt their time was utilized more effectively. In observing the disadvantages cited by the instructors in the lecture-based method, there appears to be a concern for the student as an individual with respect to ability level and motivation. These very characteristics were the ones emphasized in the advantages of the individually-paced instructional method.

1 In speaking with the instructors employing the individually-paced instructional method, the consensus for a workable ratio appeared to be one instructor for ten students or less.

Table 8 . Contingency tables showing the relationship between procrastination and instructional method for 498 and 488 subjects, respectively.

	Number of Procrasti-nators	Number of Students Passing	Total
Individually-Paced Method	42	319	361
Lecture-Based Method	11	126	137
Total	53	445	498

$\chi^2_{(1df)} = 1.36$, N.S.

	Number of Students Dropping	Number of Students Passing	Total
Individually-Paced Method	33	319	352
Lecture-Based Method	10	126	136
Total	43	445	488

$\chi^2_{(1df)} = 0.50$, N.S.

Table 8 . Continued

NOTE: The frequencies of incompletes and failures noted below were not high enough to perform chi-square analysis.

	Drops	Incompletes	Failures	Passing	Total
Individually-Paced Method	33	6	3	319	361
Lecture-Based Method	10	1	0	126	137
Total	43	7	3	445	498

Problem Statement 6

Do students under an individually-paced curriculum display a more positive affect toward subject matter than students under more conventional teaching methods?

A fifty item Likert scale (Course Evaluation, Appendix B) was administered to all students at the completion of each course. The Course Evaluation comprised eight subscales which were logically validated. These logically validated subscales may be observed in Table 9. The Course Evaluation was further validated empirically through the use of a factor analysis technique.

The technique of principal components analysis was employed using all subjects' responses (both experimental and control), experimental subjects' responses, and control subjects' responses. Results of the factor analysis on the Course Evaluation indicated fifteen major rotated factors (a varimax rotation), each possessing eigen values greater than one (for all subjects, experimental subjects only, and control subjects only). Only items "loading" greater than or equal to 0.50 were considered in the interpretation of the factors.

Although fifteen factors were extracted, only four factors were used in the analysis. These factors were chosen because they fulfilled the following criteria:

(1) Each factor had relatively few high loadings of variables (items) with the rest of the loadings very close to zero.
(2) The phraseology of each item was not biased toward the instructional method used in a course.
(3) The variables (items) loaded significantly (0.50 or greater) on both instructional methods (experimental and control).
(4) Each factor was relevant to the problem statement.

The Course Evaluation items corresponding to the four factor structures were labeled as follows:

(1) Factor I.....Course Workload and Grading.
(2) Factor II....Instructor Effectiveness.
(3) Factor III...Attitude Toward Course and Instructional Method.
(4) Factor IV....Relevancy of Course and Instructional Method.

The empirically validated subscales (Factors I, II, III, IV) with respective factor loadings are displayed in Table 10. The first subscale, "Course Workload and Grading," appears to be a combination of the logically derived subscales seven (Appropriateness of Testing) and eight (Procrastination Index). "Instructor Effectiveness," the second subscale, corresponds very closely to the original subscale five (Instructor Input). The "Attitude Toward Course and Instructional Method" subscale combines the logically derived subscales two (Attitude Toward Instructional Method) and three (Attitude Toward Course). Finally, the fourth subscale, "Relevancy of Course and Instructional Method," appears to be a composite of the logically derived subscales four (Course Content), one (Instructional Method) and eight (Procrastination Index). These empirically validated subscales were viewed substantive enough to be used in the analysis.

All of the items in each of the four subscales were dichotomously scored. An item stated in a positive manner would be scored as "1" if a response to the item was "strongly agree" or "agree." An item stated in a negative manner would be scored as "1" if a response was "strongly disagree" or "disagree." Therefore, a high point total on a subscale would indicate a positive reaction to that subscale and a low point

total would indicate a negative reaction. One-way analysis of variance results using treatment (experimental vs. control) as the main effect may be observed in Table 11.

In general, the lecture-based method was rated more positively than the individually-paced method with respect to the four subscales described. In particular, the control group scored significantly higher in six of eight courses on both the "Instructor Effectiveness" and the "Attitude Toward Course and Instructional Method" subscales. In four of eight courses the control group scored significantly higher on the "Coursework and Grading" subscale, and, in two of eight courses, the control group scored significantly higher on the subscale entitled "Relevancy of Course and Instructional Method." The remaining courses showed no significant differences between experimental and control groups on the four subscales. The results appear to indicate that students under an individually-paced curriculum do not display a more "positive affect" toward subject matter than students under more conventional teaching methods.

Table 9. Logical validation of the course evaluation into eight subscales.

Subscale 1: Instructional Method

1. I would classify the type of instruction used in this course as: (lecture-based, individually-paced, other).
10. I have frequently postponed work for this course because of demands from other courses not taught by this method.
15. I would have learned more in this course with another method of instruction.
18. Formal lecture would be the best way to conduct this course.
36. When other methods of instruction are used, I learn more.
39. This method of instruction taught me to pursue the subject on my own.
45. I would generally classify this method of instruction as lecture-oriented.
46. There were too many demands placed on the student.
48. This method of instruction enhanced student learning.
49. There were too many students in this class for this type of instruction.
50. It was difficult to see how I was progressing in this course.

Subscale 2: Attitude Toward Instructional Method

3. I was enthusiastic and receptive to this method of instruction.
23. Rather than using modules, I would have preferred learning the material in a different manner.
28. I was highly motivated by this method of instruction.
30. If another course were taught in this way, I would take it.

Subscale 3: Attitude Toward Course

4. I would recommend this course to a friend.
6. This course was intellectually stimulating to me.
9. This course was quite boring.
29. My overall evaluation of this course is excellent.
32. The course was not very interesting.
42. This was one of my poorest courses.
43. This course increased my appreciation of the subject.

Subscale 4: Course Content

7. This course material was easy to follow.
12. The sequence of materials presented in this course was excellent.
13. The course material was easily understood.
20. The educational value of this course is questionable.
27. The amount of useful material learned in this course was negligible.
38. This course taught me new ways to understand and evaluate problems.
40. The material presented in this course was much too difficult.
41. Overall, the course was well organized.
47. This course stimulated me to discuss the subject in general conversation.

Table 9 . (Continued)

Subscale 5: Instructor Input

5. The instructor made himself readily available.
8. The instructor had a good understanding of the subject matter.
17. The instructor was quite helpful.
37. The instructor played an important role in this course.
44. The instructor had a tremendous knowledge of the subject matter.

Subscale 6: Usefulness of Media Presentations

24. Not much was gained from using the media presentations.
25. The ideas and concepts were developed too rapidly to make the media presentations useful learning devices.
35. Rather than using media presentations, I learn more when other alternatives methods of learning are used.

Subscale 7: Appropriateness of Testing

2. The Summative Test (Pre and Posttest) was an accurate measure of my engineering skills in this course.
14. The tests were too difficult.
22. The grading system was quite fair.
31. The test questions used were good.

Subscale 8: Procrastination Index

11. In relation to other courses, the workload in this course was much heavier.
16. The pace of this course was too fast.
19. There were times when I felt prepared to take a module post-test, but the thought of having to get a certain percentage of the items correct caused me to put it off.
21. I have spent considerably more time in this course than in others.
26. This course caused me to make more effective use of my study time.
33. The total amount of time I usually spent in learning the material presented in each module was: (not applicable, 1 hour or less, 2-5 hours, 6-10 hours, 11-15 hours, 16-20 hours, more than 20 hours).
34. There was usually too much material to be learned in the modules.

Table 10. Course evaluation items loading 0.50 or greater for both experimental and control students.

Factor I (Course Workload and Grading):

Factor Loading	Items	
0.79	(11)	In relation to other courses, the workload in this course was much heavier.
0.65	(46)	There were too many demands placed on the student.
0.62	(40)	The material presented in this course was much too difficult.
0.61	(16)	The pace of this course was too fast.
0.60	(21)	I have spent considerably more time in this course than in others.
0.55	(22)	The grading system was quite fair.
0.52	(14)	The tests were too difficult.

Factor II (Instructor Effectiveness):

Factor Loading	Items	
0.82	(17)	The instructor was quite helpful.
0.80	(5)	The instructor made himself readily available.
0.61	(44)	The instructor had a tremendous knowledge of the subject matter.
0.60	(8)	The instructor had a good understanding of the subject matter.

Factor III (Attitude Toward Course and Instructional Method):

Factor Loading	Items	
0.79	(30)	If another course were taught in this way, I would take it.
0.75	(3)	I was enthusiastic and receptive to this method of instruction.
0.65	(4)	I would recommend this course to a friend.
0.65	(28)	I was highly motivated by this method of instruction.
0.59	(36)	When other methods of instruction are used, I learn more.
0.55	(29)	My overall evaluation of this course is excellent.

Factor IV (Relevancy of Course and Instructional Method):

Factor Loading	Items	
0.66	(26)	This course caused me to make more effective use of my study time.
0.55	(39)	This method of instruction taught me to pursue the subject on my own.
0.53	(38)	This course taught me new ways to understand and evaluate problems.
0.50	(27)	The amount of useful material learned in this course was negligible.

Table 11. Analysis of variance results for four subscales of the course evaluation in ten civil engineering technology courses.

	Course Workload and Grading				Instructor Effectiveness				Attitude Toward Course and Instructional Method				Relevancy of Course and Instructional Method			
COURSE	$\bar{X}_C$	$\bar{X}_E$	F(df)	P	$\bar{X}_C$	$\bar{X}_E$	F(df)	P	$\bar{X}_C$	$\bar{X}_E$	F(df)	P	$\bar{X}_C$	$\bar{X}_E$	F(df)	P
Highway Design and Construction	4.4 (11)	4.4 (47)	0.01 (1,52)	N.S.	4.0 (11)	3.1 (47)	7.30 (1,52)	<.01	3.3 (11)	2.5 (47)	1.33 (1,52)	N.S.	1.8 (11)	1.9 (47)	0.02 (1.52)	N.S.
Surveying II	2.7 (16)	3.3 (36)	1.33 (1,48)	N.S.	3.1 (16)	3.3 (36)	0.36 (1,48)	N.S.	0.9 (16)	1.9 (36)	3.12 (1,48)	N.S.	1.6 (16)	1.7 (36)	0.06 (1,48)	N.S.
Statics	-	1.7 (56)	-		-	2.9 (56)	-		-	0.8 (56)	-		-	1.5 (56)	-	
Surveying I	5.5 (14)	3.3 (28)	12.92 (1,39)	<.01	3.9 (14)	3.5 (28)	3.85 (1,39)	N.S.	4.3 (14)	2.8 (28)	6.24 (1,39)	<.05	2.0 (14)	1.8 (28)	0.41 (1,39)	N.S.
Structural Steel	3.4 (32)	1.6 (39)	18.65 (1,64)	<.01	4.0 (32)	2.5 (39)	50.38 (1,64)	<.01	3.3 (32)	1.1 (39)	39.57 (1,64)	<.01	2.4 (32)	1.3 (39)	15.39 (1,64)	<.01
Strength of Materials	3.1 (7)	1.9 (12)	2.18 (1,17)	N.S.	4.0 (7)	1.4 (12)	16.22 (1,17)	<.01	2.9 (7)	0.5 (12)	11.03 (1,17)	<.01	3.1 (7)	1.3 (12)	25.8 (1,17)	<.01
Hydraulics	5.3 (12)	2.9 (18)	10.00 (1,28)	<.01	4.0 (12)	3.4 (18)	4.62 (1,28)	<.05	4.3 (12)	1.0 (18)	36.55 (1,28)	<.01	2.4 (12)	1.7 (18)	2.08 (1,28)	N.S.
Cost Estimating	4.3 (16)	1.5 (13)	16.14 (1,27)	<.01	3.7 (16)	2.8 (13)	5.45 (1,27)	<.05	2.2 (16)	0.5 (13)	10.75 (1,27)	<.01	1.7 (16)	1.7 (13)	0.00 (1,27)	N.S.
Structural Concrete	3.7 (28)	2.6 (29)	3.63 (1,51)	N.S.	3.6 (28)	3.1 (29)	5.12 (1,51)	<.05	3.4 (28)	1.1 (29)	27.36 (1,51)	<.01	2.1 (28)	1.5 (29)	3.43 (1,51)	N.S.
Soil Mechanics	-	4.7 (10)	-		-	3.8 (10)	-		-	2.6 (10)	-		-	2.0 (10)	-	

NOTE:

$\bar{X}_C$ = mean of control group

$\bar{X}_E$ = mean of experimental group

Total points possible for each subscale:
(1) Course Workload and Grading.....7 points
(2) Instructor Effectiveness.....4 points
(3) Attitude Toward Course and Instructional Method...6 points
(4) Relevancy of Course and Instructional Method.....4 points

Evaluative Posttest Information Sheet Results

In order to get a better perspective on the effectiveness of materials used in the individually-paced program, a ten-item Likert scale (Evaluative Posttest Information Sheet) was completed by each student before taking a module pretest or posttest.[1] The Evaluative Posttest Information Sheet may be observed in Appendix B. Table 12 gives descriptive statistics of the module posttest information for five individually-paced Statics classes.[2] These statistics are in the form of proportions of students responding to each of the ten items on the information sheet. The results portrayed in Table 12 should be interpreted with caution, however, because there may be a built-in bias toward "negative" student ratings. In the extreme case, for example, a student who has taken module posttest #3 would also have taken at least posttest #1 and posttest #2. In this extreme case, a student's responses would have been recorded for at least three information sheets as opposed to another student who may have "mastered" posttest #1 and who has been recorded for only one information sheet; therefore, a student who has not mastered one or more posttests may have ambivalent feelings toward the mode of instruction and/or materials being used.

[1] In the individually-paced program, students were given the option of taking a module pretest or posttest. An eighty to ninety-five percent proficiency (e.g., "mastery") was required on either the module pretest or posttest before the student was permitted to move on to the next module in the course.

[2] Although the Evaluative Posttest Information Sheet was used in all of the individually-paced courses, the table is confined to Statics for several reasons. First of all, Statics was the most "advanced" individually-paced course in terms of module development and the number of media presentations available. Second, there were more individually-paced classes in Statics because it was the first fully developed course in the project. Furthermore, the results of other individually-paced courses closely parallel the results found in Statics.

The main purpose of the Evaluative Posttest Information Sheet was to obtain information from students as to the appropriateness of the instructional procedures and materials used in individually-paced courses. The first six items on the information sheet deal with the module posttests and the written modules; the last four items attempt to tap the effectiveness of the media presentations.[1]

With respect to the module posttests and the written modules in Statics, Table 12 reveals the following information. The majority of students who took the module tests took them as posttests. The very fact that some of the students recorded responses to posttest #2 and posttest #3 indicates that, in certain instances, instructors were requiring students to retake posttests in order to achieve "mastery" of the modules. The time spent in learning each module was also relatively fixed. The majority of students spent between one to five hours on each module with the exception of modules 5, 6 and 7, where the average time ranged from two to ten hours. With the exception of modules 5, 6, 7 and 10, more students agreed than disagreed that the sequence of materials within the modules was proper, the material presented was easily understood, and the amount of material required to learn was appropriate; however, the majority of students (except in the cases of modules 1, 2 and 4) indicated they would have preferred learning the material in a different manner.

As previously mentioned, the last four items of the Evaluative Post-

[1] The use of the media (slide-tape) presentations as an alternative mode to learning was viewed as an important feature of the individually-paced instructional method; however, the relative effectiveness of these media presentations to cognitive achievement was not measured due to the limited number of presentations available when particular courses were being evaluated.

test Information Sheet attempted to deal with the effectiveness of the media presentations. Although the percentage of students claiming to have viewed one or more media presentations varied from module to module (19% to 84%), an average of approximately 40% of the students claimed to have viewed one or more media presentations in each module.[1] With the exception of the last four modules in Statics (modules 7, 8, 9 and 10), the majority of those students claiming to have viewed the media presentations thought of them as useful learning devices and felt they had benefited from them; however, more students agreed than disagreed with the statement, "I learn more when other alternative methods of learning are used." This last statement might be interpreted as a plea for more alternative learning strategies or might be construed as a negative reaction to the module as a device for learning. Nevertheless, those students claiming to have used the media presentations generally thought of them as useful learning devices.

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1 This percentage may be somewhat inflated due to an observation alluded to earlier; namely, students who took more than one module posttest would have recorded responses on more than one information sheet. In contrast with the estimate, the civil engineering instructors generally agreed that approximately 20% to 25% of the students actually viewed the media presentations.

Table 12. Descriptive analysis of student responses to evaluative posttest information sheets in five individually-paced statics classes.

Module # 1 (N = 88)

Item #	1		2	3	4	5		6		7		8	9	10
Type of Test		Degree of Response					Time Spent		# Media Shows Viewed		Degree of Response			
Pretest	.07	NA	-	-	.02	-	1 hr.	.42	0	.81	NA	-	-	-
Posttest #1	.93	SD	.01	.02	.11	.18	2-5 hrs.	.52	1	.11	SD	.31	.19	.19
Posttest #2	-	D	.03	.02	.35	.58	6-10 hrs.	.05	2	.07	D	.44	.36	.44
Posttest #3	-	N	.25	.14	.34	.16	11-15 hrs	.01	3	.01	N	.25	.05	.12
.		A	.64	.72	.09	.03	16-20 hrs	-	4	-	A	-	.38	.25
		SA	.07	.10	.09	.05	20+ hrs.	-			SA	-	-	-

Module # 2 (N = 79)

Item #	1		2	3	4	5		6		7		8	9	10
Type of Test		Degree of Response					Time Spent		# Media Shows Viewed		Degree of Response			
Pretest	.08	NA	.01	.01	-	-	1 hr.	.14	0	.56	NA	-	-	-
Posttest #1	.67	SD	.01	.04	.11	.05	2-5 hrs.	.58	1	.14	SD	.23	.09	.14
Posttest #2	.24	D	.20	.15	.34	.53	6-10 hrs.	.24	2	.10	D	.49	.29	.40
Posttest #3	.01	N	.22	.33	.28	.23	11-15 hrs	.03	3	.06	N	.14	.30	.23
.		A	.52	.42	.18	.13	16-20 hrs	.01	4	.14	A	.14	.29	.20
		SA	.04	.05	.09	.06	20+ hrs.	-			SA	-	.03	.03

Module # 3 (N = 69)

Item #	1		2	3	4	5		6		7		8	9	10
Type of Test		Degree of Response					Time Spent		# Media Shows Viewed		Degree of Response			
Pretest	-	NA	-	-	.01	-	1 hr.	.20	0	.80	NA	-	-	-
Posttest #1	.84	SD	.01	.04	.01	.06	2-5 hrs.	.61	1	.19	SD	.14	.21	.07
Posttest #2	.12	D	.14	.16	.20	.45	6-10 hrs.	.19	2	.01	D	.64	.29	.57
Posttest #3	.04	N	.36	.33	.42	.35	11-15 hrs	-	3	-	N	.15	-	.36
.		A	.46	.46	.20	.10	16-20 hrs	-	4	-	A	.07	.50	-
		SA	.03	.01	.16	.04	20+ hrs.	-			SA	-	-	-

Module # 4 (N = 77)

Item #	1		2	3	4	5		6		7		8	9	10
Type of Test		Degree of Response					Time Spent		# Media Shows Viewed		Degree of Response			
Pretest	.03	NA	-	-	.01	.01	1 hr.	.20	0	.59	NA	-	-	-
Posttest #1	.84	SD	-	.04	.08	.04	2-5 hrs.	.64	1	.09	SD	.13	.13	.22
Posttest #2	.12	D	.17	.14	.31	.52	6-10 hrs.	.14	2	.27	D	.66	.41	.41
Posttest #3	.01	N	.30	.30	.26	.33	11-15 hrs	.01	3	.04	N	.15	.15	.19
.		A	.48	.47	.23	.09	16-20 hrs	-	4	.01	A	.06	.31	.16
		SA	.05	.05	.13	.01	20+ hrs.	.01			SA	-	-	.02

Table 12. Continued.

Module # 5 (N = 77)

Item #	1		2	3	4	5		6		7		8	9	10
Type of Test		Degree of Response					Time Spent		# Media Shows Viewed		Degree of Response			
Pretest	.04	NA	-	-	.01	-	1 hr.	.04	0	.31	NA	-	-	-
Posttest #1	.83	SD	.04	.09	.05	.03	2-5 hrs.	.45	1	.08	SD	.19	.06	.06
Posttest #2	.09	D	.25	.35	.17	.18	6-10 hrs.	.34	2	.36	D	.36	.25	.23
Posttest #3	.04	N	.49	.33	.28	.31	11-15 hrs	.06	3	.21	N	.30	.32	.47
		A	.21	.22	.31	.27	16-20 hrs	.06	4	.04	A	.13	.26	.15
		SA	.01	.01	.18	.21	20+ hrs.	.05			SA	.02	.11	.09

Module # 6 (N = 52)*

Item #	1		2	3	4	5		6		7		8	9	10
Type of Test		Degree of Response					Time Spent		# Media Shows Viewed		Degree of Response			
Pretest	.04	NA	.02	-	-	-	1 hr	.06	0	.56	NA	-	-	-
Posttest #1	.77	SD	.04	.12	.04	.06	2-5 hrs.	.38	1	.25	SD	.09	.04	.04
Posttest #2	.17	D	.25	.33	.10	.15	6-10 hrs.	.35	2	.13	D	.35	.09	.30
Posttest #3	.02	N	.48	.34	.36	.45	11-15 hrs	.15	3	.06	N	.39	.61	.53
		A	.21	.21	.29	.21	16-20 hrs	-	4	-	A	.17	.22	.13
		SA	-	-	.21	.13	20+ hrs.	.06			SA	-	.04	-

Module 7 (N = 25)**

Item #	1		2	3	4	5		6		7		8	9	10
Type of Test		Degree of Response					Time Spent		# Media Shows Viewed		Degree of Response			
Pretest	-	NA	-	-	-	-	1 hr.	-	0	.16	NA	-	-	-
Posttest #1	.84	SD	.08	.24	-	.04	2-5 hrs.	.44	1	.16	SD	.05	.05	-
Posttest #2	.16	D	.12	.20	.04	.12	6-10 hrs.	.20	2	.44	D	.29	.05	.10
Posttest #3	-	N	.68	.40	.32	.40	11-15 hrs	.16	3	.16	N	.23	.37	.80
		A	.12	.16	.28	.20	16-20 hrs	.04	4	.08	A	.29	.29	-
		SA	-	-	.36	.24	20+ hrs.	.16			SA	.14	.24	.10

Module # 8 (N = 32)

Item #	1		2	3	4	5		6		7		8	9	10
Type of Test		Degree of Response					Time Spent		# Media Shows Viewed		Degree of Response			
Pretest	.06	NA	.03	.03	.03	.03	1 hr.	.31	0	.62	NA	-	-	-
Posttest #1	.94	SD	-	.03	-	.09	2-5 hrs.	.50	1	.38	SD	-	-	-
Posttest #2	-	D	.21	.16	.06	.31	6-10 hrs.	.13	2	-	D	.50	-	.08
Posttest #3	-	N	.38	.34	.41	.35	11-15 hrs	.03	3	-	N	-	.17	.26
		A	.38	.44	.31	.19	16-20 hrs	-	4	-	A	.50	.58	.58
		SA	-	-	.19	.03	20+ hrs.	.03			SA	-	.25	.08

Table 12. Continued.

Module 9 (N = 34)

Item #	1		2	3	4	5		6		7		8	9	10
Type of Test		Degree of Response					Time Spent		# Media Shows Viewed		Degree of Response			
Pretest	.06	NA	-	-	-	-	1 hr.	.21	0	.65	NA	-	-	-
Posttest #1	.85	SD	.12	.12	.03	.03	2-5 hrs.	.59	1	.35	SD	-	.08	-
Posttest #2	.09	D	.15	.18	.06	.32	6-10 hrs.	.15	2	-	D	.08	.C8	-
Posttest #3	-	N	.35	.35	.41	.44	11-15 hrs	.05	3	-	N	.34	.17	.67
		A	.32	.29	.12	.18	16-20 hrs	-	4	-	A	.58	.50	.33
		SA	.06	.06	.38	.03	20+ hrs.	-			SA	-	.17	-

Module # 10 (N = 20)

Item #	1		2	3	4	5		6		7		8	9	10
Type of Test		Degree of Response					Time Spent		# Media Shows Viewed		Degree of Response			
Pretest	.10	NA	-	-	-	-	1 hr.	.15	0	.60	NA	-	-	-
Posttest #1	.90	SD	.05	.15	-	-	2-5 hrs.	.65	1	.40	SD	-	-	-
Posttest #2	-	D	.20	.25	.10	.15	6-10 hrs.	.15	2	-	D	-	.13	.13
Posttest #3	-	N	.60	.35	.40	.40	11-15 hrs	.05	3	-	N	.75	.49	.62
		A	.15	.25	.15	.40	16-20 hrs	-	4	-	A	.25	.13	.25
		SA	-	-	.35	.05	20+ hrs.	-			SA	-	.25	-

NOTE:

The proportions listed for items 8, 9, and 10 of each module are derived from only those students who viewed one or more media shows.

*The number of student responses (N) decreases sharply after Module #5. This reduction is due, in part, to the fact that one instructor told two statics classes (N = 40) there would be no penalty for not completing the course in the allotted eleven-week quarter.

**The student responses of one statics class (N = 21) were not available for Module #7.

Summary

The evaluation was based on a pretest/posttest design to compare two operationally defined instructional strategies: an individually-paced method and a lecture-based method. The effectiveness of the individually-paced format was determined primarily through the analysis of six evaluation problem statements and the Evaluative Posttest Information Sheet. Due to the limited time allotted for the evaluation and the relatively small number of classes investigated within each course, the results must be viewed as tentative.

In terms of cognitive achievement, the individually-paced students did relatively well. Although the results were not dramatic, the individiually-paced students generally outperformed the lecture-based students in terms of student exit behaviors (as measured by the Summative Posttests); however, the range of scores was slightly greater for individually-paced students than for lecture-based students. More variability in terms of student exit behaviors was not anticipated in a learning for mastery strategy. The experimental group also scored higher than the control group on a ten-week retention test in Structural Steel, although the results were not statistically significant.

In contrast to the results found in cognitive achievement, individually-paced students did not appear to display a more positive affect toward subject matter than lecture-based students. In fact, four empirically validated subscales (Course Workload and Grading, Instructor Effectiveness, Attitude Toward Course and Instructional Method, and Relevancy of Course and Instructional Method) were rated higher by lecture-based students in the majority of courses. This apparent discrepancy

between the cognitive and affective domains may be related to the fact that the individually-paced instructional method was totally new to the students and that the students were required to become more active participants in the learning process.

Aside from affective and cognitive characteristics, the topics of procrastination and final grade distribution were investigated. In the evaluation, the definition of a procrastinator was expanded to include any student who dropped a course, received an incomplete, or failed a course. Using this definition, a chi-square analysis indicated there was no observed tendency for students to procrastinate more in individually-paced courses than in lecture-based courses. With respect to final grades assigned to students, a chi-square analysis in one course (Structural Concrete) revealed there was no reliable relationship observed between final grades assigned and instructional method employed. This apparent independent relationship was interesting in light of the fact that statistically significant differences favoring the experimental group were found on the Structural Concrete Summative Posttest.

The adequacy of the materials used in the individually-paced format was also investigated. Although the results obtained from the Evaluative Posttest Information Sheet were limited to one course (Statics), individually-paced students generally indicated that the sequence of materials within the modules was proper, the material presented was easily understood, and the amount of material required to learn was appropriate. Students also felt that the media presentations were useful learning devices and that they benefited from them. When the individually-paced materials were used in an institution outside the state of South Carolina, the results

from one course (Surveying II) tended to support the idea that these materials could be used effectively elsewhere.

There were indications, however, that individually-paced students would have preferred learning the material (e.g., modules and media presentations) in a different manner. These indications were born out of information gathered from the Evaluative Posttest Information Sheets, Course Evaluations, Course Questionnaires and Instructor Questionnaires. Results from these measuring instruments indicated that students would have preferred more instructor input as well as a more rigidly defined course time-table. Students also complained that there were too many students per instructor in the individually-paced courses. On the other hand, instructors stressed the importance of the individually-paced method in terms of student ability and motivation. Viewing the disadvantages of the individually-paced method, the instructor-student ratio appeared to be the critical feature. If the ratio is reasonably low (e.g., one instructor for every ten students), the disadvantages of the individually-paced method appear to be minimal.

APPENDIX A

OPERATIONAL FEATURES OF THE INDIVIDUALLY-PACED AND LECTURE-BASED INSTRUCTIONAL STRATEGIES

Table 13. Distinguishing characteristics of the individually-paced and lecture-based instruction.

Table 14. Guidelines given to "individually-paced" instructors for data collection.

Table 15. Guidelines given to "lecture-based" instructors for data collection.

Table 13. Distinguishing characteristics of the individually-paced and lecture-based instruction.

Distinctive Features of the Individually-Paced Curriculum

1. Students work individually using modules.
2. Student use of media (slide-tape) presentations (if available).
3. Formative testing: administering posttests to students after completion of modules.
4. Formative tests (module posttests) are "non-graded."
5. Retesting "non-masters" (less than 80% correct) with parallel posttests before moving on to next module.
6. Setting a criterion level (80-95% correct) for "mastery" of the module posttests.
7. Summative Posttest ("final") accounts for total grade.*
8. Student objectives will be stressed in each module.
9. Predetermined time frame will be established for completing individual modules (as indicated by the Student Progress Charts).
10. The main method of instruction will not be lecture-based; however if students are having problems within a certain area of a module, then students may be given a group presentation (or individual attention) in that particular area.
11. In order to provide students with proper feedback, module posttests should be corrected immediately (student tutors or the individual students themselves may be used to correct module posttests under the instructor's supervision).
12. Attendance regulations will be adhered to.

*NOTE: A "Mid-Term," consisting of items from the module posttests, may be given if the instructor does not feel that the Summative Posttest should account for the total grade. The "Mid-Term" is optional.

Distinctive Features of the Lecture-Based Curriculum

1. Students will not have access to modules.
2. Students will not have access to slide-tape presentations; however, other presentations such as films may be used.
3. Administering unit tests (2 to 4, including final) consisting of selected items from the module posttests.
4. Unit tests will be graded.
5. There will be no retesting given to students on the unit tests.
6. The grading system on unit tests will be determined by the instructor.
7. The Summative Posttest ("final") does not account for the student's total grade.
8. Student objectives in each module will be covered by the instructor.
9. All of the essential student objectives in the course will be covered by the instructor.
10. The main method of instruction will be lecture-based.
11. Unit tests will be graded by the instructor.
12. Attendance regulations will be adhered to.

Table 14. Guidelines given to "individually-paced" instructors for data collection.

Responsibilities for Instructors (Individually-Paced Curriculum)

The following list is a reminder of the information needed for the successful evaluation of this project. The steps involved are listed in their appropriate sequence. Hopefully, this list will enable you to keep track of all the information that is required throughout the quarter.*

1. Administering and collecting the CPP (abbreviated Career Planning Profile) and answer sheets during first week of class.

   If the students have already taken this version of the CPP, they are not required to take it again. Each student should be given two answer sheets and his social security number should be on both sheets. Calculators and slide rules are not allowed.

2. Administering and collecting pretests (final exams) and answer sheets during first week of class.

   The final exam is given to the class as a pretest to determine the students' entering characteristics. They should be given two (2) hours to complete this test. Calculators and slide rules are allowed.

3. Administering and collecting the Evaluative Posttest Information Sheets throughout the quarter.

   Every time a student is ready to take a module pre- or posttest, he must answer items 1-10 of the Evaluative Posttest Information Sheet in columns 1-10 of a computer answer sheet (Form CC203). These computer answer sheets should be filed by the appropriate module number in order that they may be correctly coded at a later date.

4. Administering and collecting posttests (final exams) and answer sheets during last week of class or during the final exam period.

   The posttest is the same as the pretest and the students should be given the same two (2) hour time limit to complete this test.

5. Administering and collecting Course Evaluations and answer sheets after the final exam (posttest) has been completed.

   It is important for the students to fill in the Course Evaluation after they have completed their final exams and not before. Some of the items relate to the final exam. Students should not place their social security numbers on the answer sheets.

6. Complete Instructor Questionnaire during last week of class.

   This questionnaire calls for the three (3) major advantages and disadvantages pertaining to this particular course with an individually-paced method of instruction.

Table 14. Continued

Responsibilities for Instructors (Individually-Paced Curriculum)

7. Tabulate a list of students who have received an incomplete, failed, or dropped your course.

   Please include the home addresses of these students. Questionnaires will be sent to these students in an attempt to resolve certain issues concerning student procrastination.

*NOTE: All of the information collected should be on the computer answer sheets (Form CC203). These are to be filled in with pencils only.

Table 15. Guidelines given to "lecture-based" instructors for data collection.

Responsibilities for Instructors (Lecture-Based Curriculum)

The following list is a reminder of the information needed for the successful evaluation of this project. The steps involved are listed in their appropriate sequence. Hopefully, this list will enable you to keep track of all the information that is required throughout the quarter.*

1. Administering and collecting the CPP (abbreviated Career Planning Profile) and answer sheets during the first week of class.

   If the students have already taken this version of the CPP, they are not required to take it again. Each student should be given two answer sheets and his social security number should be on both sheets. Calculators and slide rules are not allowed.

2. Administering and collecting pretests (final exams) and answer sheets during first week of class.

   The final exam is given to the class as a pretest to determine the students' entering characteristics. They should be given two (2) hours to complete this test. Calculators and slide rules are allowed.

3. Administering and collecting posttests (final exams) and answer sheets during last week of class or during the final exam period.

   The posttest is the same as the pretest and the students should be given the same two (2) hour time limit to complete this test.

4. Administering and collecting Course Evaluations and answer sheets after the final exam (posttest) has been completed.

   It is important for the students to fill in the Course Evaluation after they have completed their final exams and not before. Some of the items relate to the final exam. Some of the items also relate to an individually-paced method of instruction. For these, the student should respond with "not applicable" (NA). Students should not place their social security numbers on the answer sheets.

5. Complete Instructor Questionnaire during last week of class.

   This questionnaire calls for the three (3) major advantages and disadvantages pertaining to this particular course with a lecture-based method of instruction.

6. Tabulate a list of students who have received an incomplete, failed or dropped your course.

   Please include the home addresses of these students. Questionnaires will be sent to these students in an attempt to resolve certain issues concerning student procrastination.

*NOTE: All of the information collected should be on the computer answer sheets (Form CC203). These are to be filled in with pencils only.

APPENDIX B

MEASURING INSTRUMENTS USED IN THE EVALUATION

Table 16. Statics summative pretest/posttest with accompanying answer sheet and formula sheet.

Table 17. Course evaluation.

Table 18. Course questionnaire.

Table 19. Evaluative posttest information sheet.

Table 20. Instructor questionnaire.

Table 16. Statics summative pretest/posttest with accompanying answer sheet and formula sheet.

DIRECTIONS

This booklet contains a total of fifty (50) multiple-choice items designed to measure your civil engineering skills.

You will use one (1) answer sheet (Form CC203) provided to answer all the items in this booklet. For each item in this booklet, there is a matching column of **ovals** on the answer sheet. After you select your answer to each item, locate the column of ovals on the answer sheet numbered the same as the item. Find the **oval** in the row that corresponds to the answer you have selected. Then make a heavy black mark that completely fills the oval. Use a **soft lead pencil** and mark with a circular motion. The important thing is to make a **heavy mark** that can be read easily.

If you change your mind about an answer, be sure to **erase** your first mark thoroughly. Make certain each time that your mark is placed in the column with the **same** number as the item.

You will notice that the items begin with item number eleven (11). The first ten (10) columns on each answer sheet require your social security number **and** your status in school. Please blacken the appropriate ovals for your **social security number** in the **first nine (9) columns** of your answer sheet. In column number **ten** (10) blacken the appropriate oval for your **status in school** (first year = 1; second year = 2). Please fill in the first ten (10) columns of your answer sheet with your social security number and your status in school **at this time**.

You should also have an accompanying **Formula Sheet** to be used with this booklet. This sheet contains formulas which may be used in answering the items in the booklet. You will also be permitted to use slide rules or calculators in your figuring.

PLEASE DO NOT OPEN THIS BOOKLET UNTIL TOLD TO DO SO.

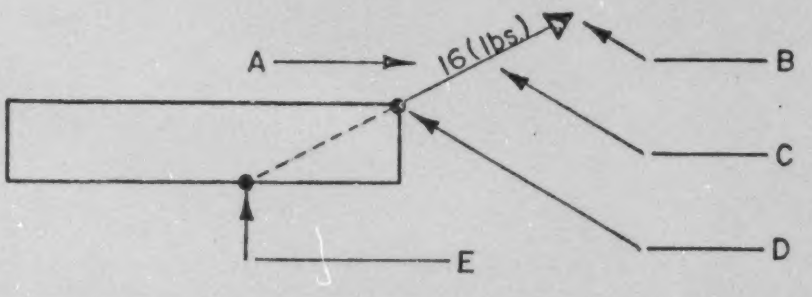
STATICS

11. Statics may be defined as the study of:

    1. the dynamics and strengths of materials
    2. forces and their effects on bodies at rest
    3. the dynamics of internal and external forces
    4. forces and their effects on bodies in motion.

12. The magnitude of a force is found to be 3.2 kips. Expressed in pounds this force would have a magnitude of:

    1. 0.0032 lb.
    2. 312.5 lb.
    3. 320 lb.
    4. 3200 lb.



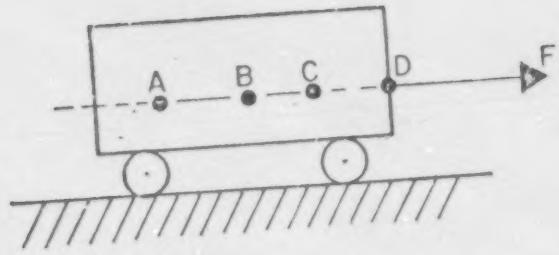
Items 13-14 pertain to the above figure. Match the letters in the figure to the following items.

13. Point of application:

    1. A
    2. B
    3. D
    4. E

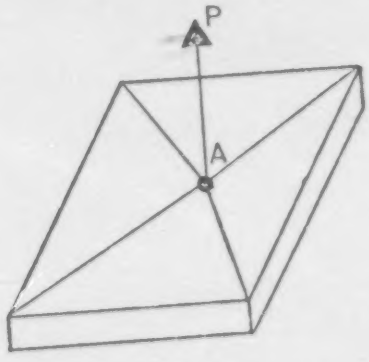
14. Sense:

    1. A
    2. B
    3. C
    4. D



15. Consider the above illustration. The principle of transmissibility states that the force F will be most effective when applied to point(s):

1. D
2. A or C
3. B, C, or D
4. A, B, C, or D.



16. The force system in the above illustration would be labelled as:

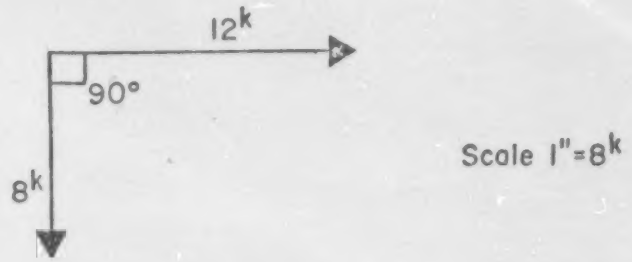
1. noncoplanar and concurrent
2. noncoplanar and nonconcurrent
3. coplanar and concurrent
4. noncoplanar and parallel.

17. The first logical step in solving for the resultant of two forces using the graphical method would be to:

    1. draw the resultant which is the vector summation of the two force vectors
    2. determine the magnitude, direction and sense of the resultant
    3. establish an origin point and select one of the force vectors transferring it by the parallel line technique
    4. draw the vectors to scale if they are not already drawn to scale.

18. When vectors are being drawn to scale to find the resultant using the graphical method, it is best to have the drawing:

    1. smaller than the original vectors
    2. the exact same size as the original vectors
    3. larger than the original vectors
    4. it does not matter what size scale is used.

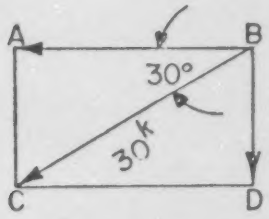


19. Using the above diagram, the resultant force would be:

    1. 4^k
    2. 8.94^k
    3. 14.42^k
    4. 20^k

20. Using the above information, the θ angle would be:

    1. 23^o - 58'
    2. 33^o - 41'
    3. 44^o - 00'
    4. 67^o - 00'

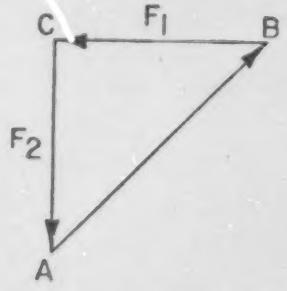


21. Using the information provided above, the vertical component (BD) would be:

    1. 15^k
    2. 25.98^k
    3. 34.64^k
    4. 60^k

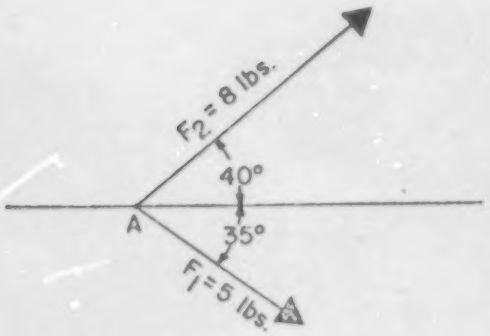
22. The horizontal component in the above problem would equal:

    1. 15^k
    2. 25.98^k
    3. 34.64^k
    4. 60^k



23. In the above diagram, AB would be called a(n):

    1. F_3
    2. $F(\uparrow)$
    3. resultant
    4. reaction.



24. In the above figure, the reaction R required to equilibrate point A with F_1 and F_2 acting on it would be:

    1. -8.01 lb.
    2. 10.22 lb.
    3. 10.22 (←) lb.
    4. 10.38 (→) lb.

25. In order for a body to be in static equilibrium:

    1. the summation of all vertical forces acting on the body must be zero
    2. the summation of all horizontal forces acting on the body must be zero
    3. answers 1 and 2 must be true
    4. none of the above answers need to be satisfied.

26. Reactions may be thought of as being:

    1. active forces
    2. applied loads
    3. passive forces
    4. resultants.

27. The perpendicular distance from the pivot to the line of action of the force is known as the:

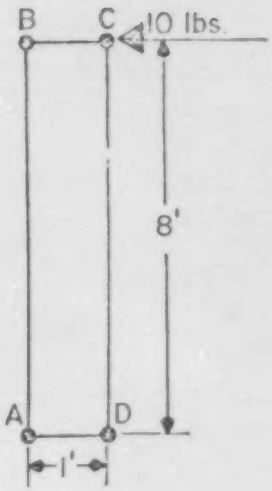
    1. moment of force
    2. moment
    3. vector of applied force
    4. moment arm.

28. A beam 15 ft. long is supported at the ends. A load of 800 pounds is placed 4 ft. from the left end. The reactions would be approximately:

    1. 73 lb., 200 lb.
    2. 200 lb., 600 lb.
    3. 213 lb., 586 lb.
    4. 400 lb., 400 lb.

29. Forces of 10 lb. each are applied on opposite sides of the steering wheel 16" in diameter to form a couple. The moment of the couple would be:

1. 0 in. - lb.
2. 80 in. - lb.
3. 160 in. - lb.
4. 320 in. - lb.



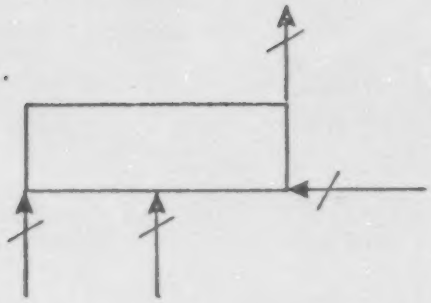
30. From the above diagram, the moment about point A would be:

1. 5 ft. - lb.
2. 10 ft. - lb.
3. 40 ft. - lb.
4. 80 ft. - lb.

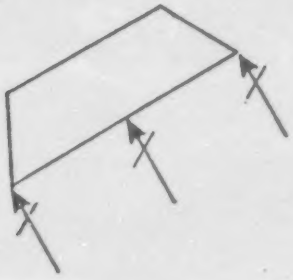
31. Of the following, the one unit for moments that would not be appropriate would be:

1. kilogram - meter
2. foot - kip
3. inch - pound
4. foot - pound.

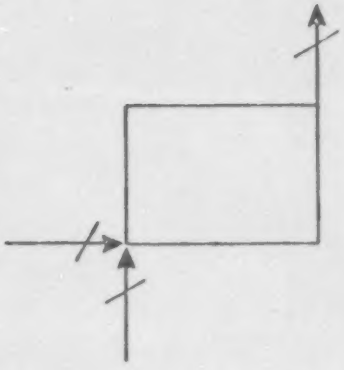
A.



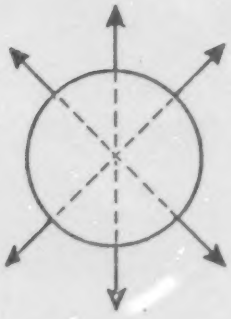
B.



C.



D.



Items 32 - 34 pertain to the above figures (A,B,C,D). Determine which of the above figure(s) correspond to the label(s) provided.

32. Unstable and statically indeterminate:

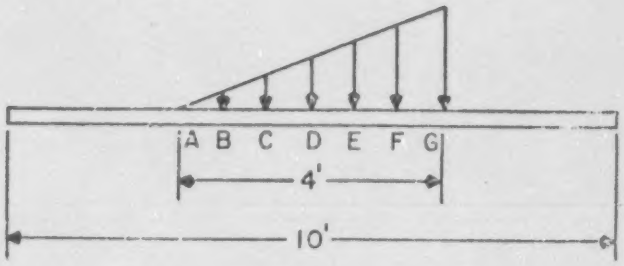
1. A
2. B
3. C
4. D

33. Stable and statically determinate:

1. A
2. B
3. C
4. D

34. Unstable:

1. A
2. B
3. C
4. D



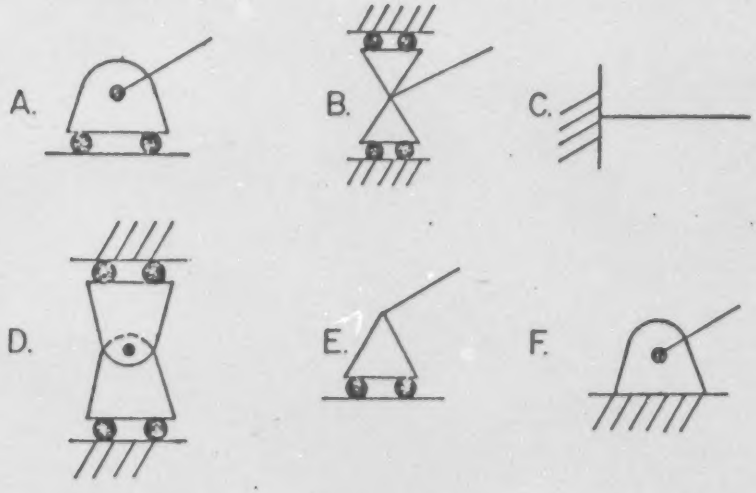
35. In the above figure, a triangular load varies from 0 to 3 kips per foot and acts over 4 feet of a 10 foot beam. Its equivalent concentrated load would be equal to:

1. 6^k
2. 12^k
3. 15^k
4. 30^k

36. Referring again to the above figure, the equivalent concentrated load would be shown at point(s):

1. B or E
2. D
3. E
4. F

The following figure displays various symbols used for types of supports in diagrams:



From the above information, determine the appropriate symbols for items 37 - 39.

37. Bushing - type support(s):

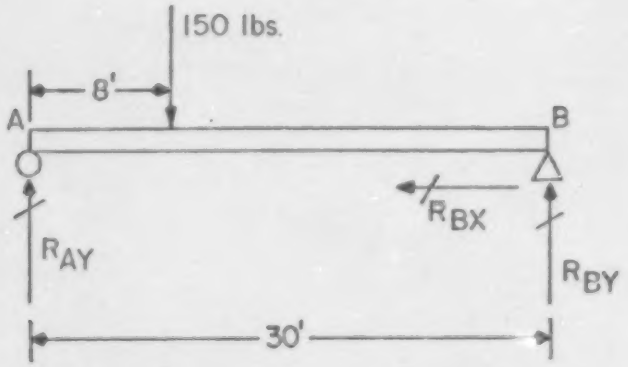
1. A
2. B
3. B,D
4. A,B,D,E

38. Fixed - end support(s):

1. B
2. C
3. B,D
4. F

39. Pinned connection support(s):

1. A,F
2. B,D
3. C
4. F

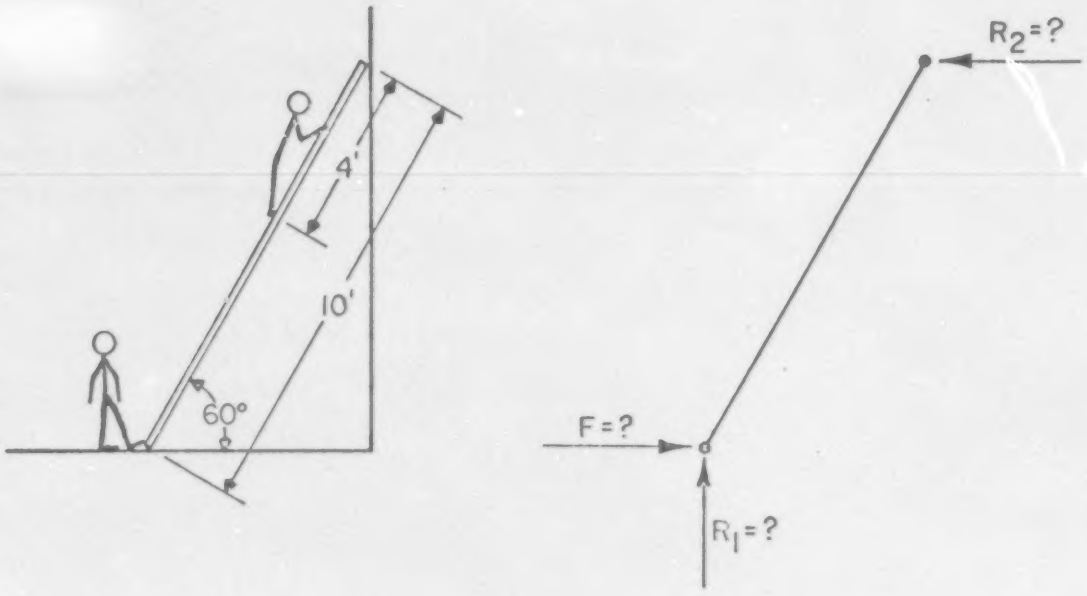


40. The above figure is a free-body diagram of a beam with a 150 lb. vertical load to the beam 8 feet from the support at A. In this example R_{AY} would be:

1. 40 lb.
2. 80 lb.
3. 110 lb.
4. 412 lb.

41. If R_{AY} had been equal to 100 lb. in the above problem, then R_{BY} would have been:

1. -50 lb.
2. 50 lb.
3. 150 lb.
4. 250 lb.



A 10-foot ladder rests against a smooth wall. The ladder weighs 20 lb. A 180 lb. man stands on it, as shown in the above figure, while his helper holds his foot against the bottom to prevent the ladder from slipping on the smooth floor.

From the above figure and information, determine the unknown force and reactions in items 42 - 44.

42. R_1:

1. 160 lb.
2. 180 lb.
3. 200 lb.
4. 204 lb.

43. R_2:

1. 47 lb.
2. 68 lb.
3. 204 lb.
4. 681 lb.

44. F:

1. 47 lb.
2. 68 lb.
3. 70 lb.
4. 204 lb.

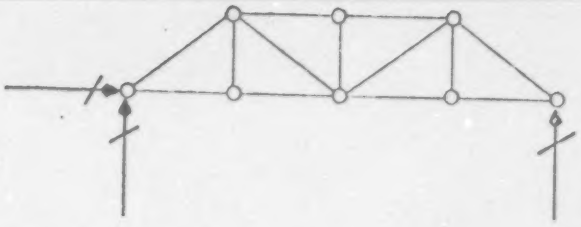


FIG. A

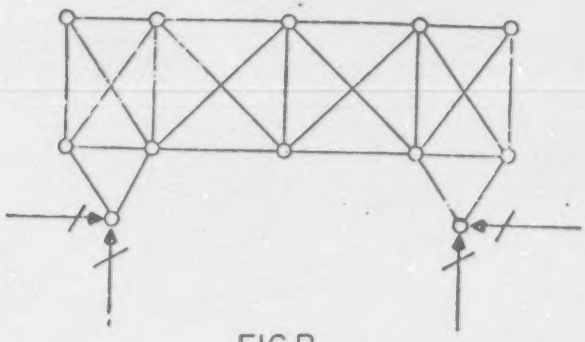


FIG. B

Items 45 - 46 pertain to the above figures.

45. The truss in Figure A is:

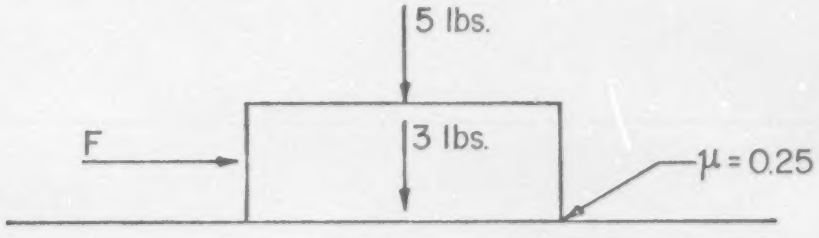
1. stable and statically determinate
2. stable and statically indeterminate
3. unstable
4. non - determinable.

46. The truss in Figure B is:

1. stable and statically determinate
2. stable and statically indeterminate
3. unstable
4. non - determinable.

47. The frictional force is dependent upon the:

1. normal force and coefficient of friction
2. contact surface area
3. contact surface area and coefficient of friction
4. contact surface area, normal force and coefficient of friction.



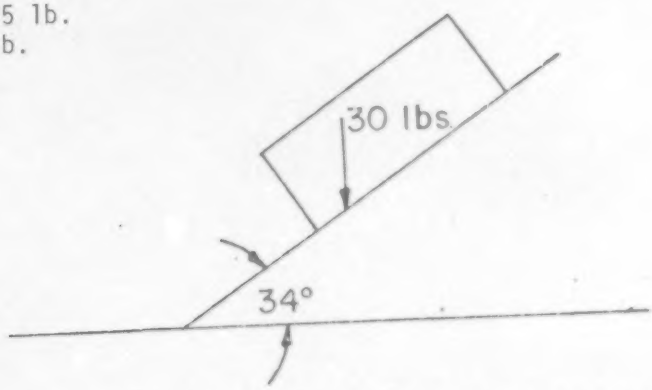
Items 48 - 49 pertain to the above figure.

48. The normal force would be:

1. 2 lb.
2. 3 lb.
3. 5 lb.
4. 8 lb.

49. The maximal frictional resistance would be:

1. 0.25 lb.
2. 0.75 lb.
3. 1.25 lb.
4. 2 lb.



In the above figure, a 30 lb. block is on an inclined plane of 34^{o}. Items 50 - 51 pertain to this figure.

50. The coefficient of friction would be:

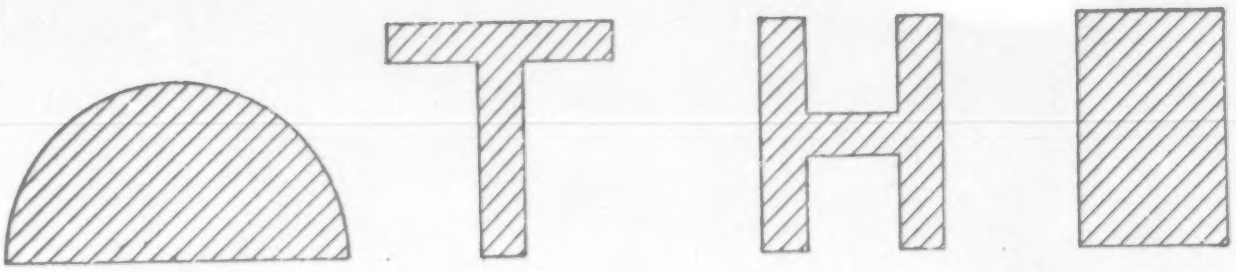
1. 0.55
2. 0.67
3. 0.82
4. 0.88

51. The force F which tends to move the block would be:

1. 16.8 lb.
2. 20.2 lb.
3. 24.9 lb.
4. 26.4 lb.

52. The first logical step in finding a centroid would involve:

1. dividing the shape into as many simple shapes as possible
2. finding the area moment of the geometric shape about the x and y base lines
3. drawing the x and y base lines on the left and bottom edges of the section
4. finding the horizontal and vertical distances from the base lines to the centroidal axes of each simple shape.



A. B. C. D.

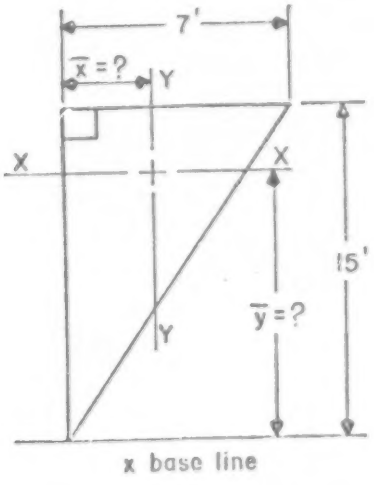
The above figures (A,B,C,D) pertain to items 53 - 54.

53. The figure(s) having <u>one axis of symmetry</u>:

1. A
2. A,B
3. B,C
4. D

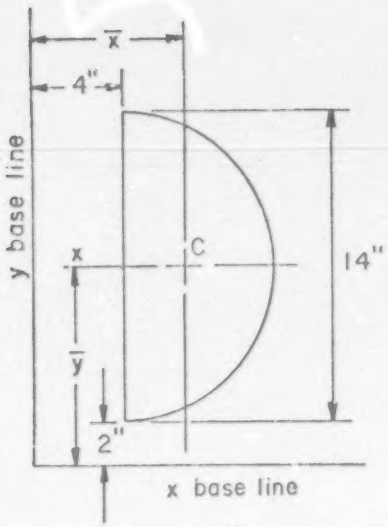
54. The figure(s) having <u>two axes of symmetry</u>:

1. B
2. B,C
3. A,B
4. C,D



55. Using the above figure, the $\bar{x}$ and $\bar{y}$ <u>distances</u> to the centroidal axes measured from the given base lines would be:

1. $\bar{x}$ = 2.3', $\bar{y}$ = 10'
2. $\bar{x}$ = 5', $\bar{y}$ = 4.7'
3. $\bar{x}$ = 10', $\bar{y}$ = 2 3'
4. $\bar{x}$ = 4.7', $\bar{y}$ = 5'



56. In the above figure, the area moment about the y base line is:

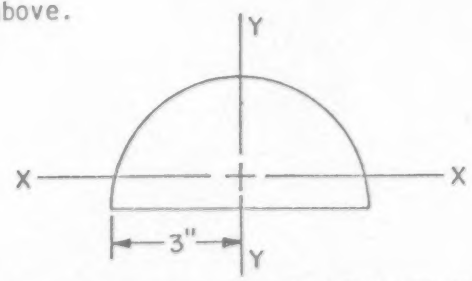
1. 77 in.^{2}
2. 307.9 in.^{3}
3. 536.5 in.^{3}
4. 1231.5 in.^{3}

57. Simply stated, moments of inertia are determined by:

1. multiplying an area by the square of a distance
2. calculating the centroid of a geometric figure
3. dividing an area by the square of a distance
4. dividing the square of a distance by an area.

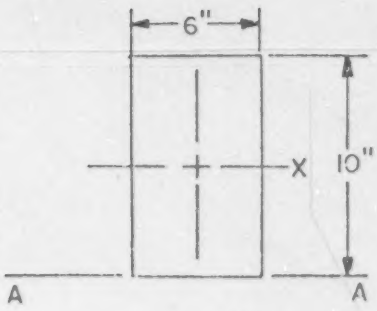
58. Moments of inertia are dependent on a section's:

1. shape
2. material
3. weight
4. all of the above.



59. In the above diagram, the moment of inertia of the semicircle about the horizontal axis would be:

1. 2.84 in.^{4}
2. 8.91 in.^{4}
3. 31.8 in.^{4}
4. 142.56 in.^{4}



60. The moment of inertia of a 6-by 10-in. rectangle about its 6-in. base in the above figure would be:

1. 500 $in.^4$
2. 800 $in.^4$
3. 1000 $in.^4$
4. 2000 $in.^4$

STATICS

Module		
1	K	(11)2
	C	(12)4
	K	(13)3
	K	(14)2
	C	(15)4
	K	(16)1
2	K	(17)4
	K	(18)3
	C	(19)3
	C	(20)2
	C	(21)1
	C	(22)2
3	K	(23)4
	C	(24)3
	K	(25)3
	K	(26)3
4	K	(27)4
	C	(28)3
	C	(29)3
	C	(30)4
	K	(31)1
5	C	(32)2
	C	(33)1
	C	(34)4
	C	(35)1

Module		
6	C	(36)3
	K	(37)3
	K	(38)2
	K	(39)4
	C	(40)3
	C	(41)2
7	C	(42)3
	C	(43)2
	C	(44)2
	C	(45)1
	C	(46)2
8	K	(47)1
	C	(48)4
	C	(49)4
	C	(50)2
	C	(51)1
9	K	(52)3
	K	(53)2
	K	(54)4
	C	(55)1
	C	(56)3
10	K	(57)1
	K	(58)1
	C	(59)2
	C	(60)4

FORMULA SHEET: STATICS

1 kip = 1,000 pounds
1 ton = 2,000 pounds
1 newton = 0.2248 pounds

RESULTANT $R = \sqrt{(F_1)^2 + (F_2)^2}$

$\text{SIN } \theta = \frac{\text{opposite side}}{\text{hypotenuse}}$

$\text{COS } \theta = \frac{\text{adjacent side}}{\text{hypotenuse}}$

$\text{TAN } \theta = \frac{\text{opposite side}}{\text{adjacent side}}$

R = reaction
F_R = force resultant
F_x = horizontal component of a given force vector
F_y = vertical component of a given force vector
Σ = summation of

horizontal component (F_x) = force x $\frac{\text{horizontal side}}{\text{hypotenuse}}$ of a slope triangle

vertical component (F_y) = force x $\frac{\text{vertical side}}{\text{hypotenuse}}$ of a slope triangle

$F_R = \sqrt{(\Sigma F_x)^2 + (\Sigma F_y)^2}$

$\Sigma F_y = 0$
$\Sigma F_x = 0$ Law of Statics Equilibrium for a coplanar, concurrent system of forces

---

moment = force x moment arm

M = moment
ΣM_A = sum of moments about point A

R_{Ay} = vertical reaction at A

R_{Ax} = horizontal reaction at A

$N = M + R - 2J$

N = degree of indeterminancy or redundancy
M = number of members in truss
J = number of joints in truss
R = number of independent reaction elements (individual reaction capabilities)

$\mathcal{F} = \mu \times N$

$\mathcal{F}$ = maximum frictional resistance
μ = coefficient of static friction
N = normal

$F = W \text{ SIN } \theta$
$N = W \text{ COS } \theta$

$\mu = \frac{W \text{ SIN } \theta}{W \text{ COS } \theta} = \text{TAN } \theta$

θ = angle of repose

$\bar{x} = 1/2\ b$
$\bar{y} = 1/2\ h$ (rectangle)

$\bar{x} = \bar{y} =$ r (circle)

$\bar{x} = \frac{4r}{3\pi}$, $\bar{y} = r$
or (semicircle)
$\bar{x} = r$, $\bar{x} = \frac{4r}{3\pi}$

$\bar{x}$ = distance from the y base line to the YY axis (measured horizontally)
$\bar{y}$ = distance from the x base line to the XX axis (measured vertically)
b = base
h = height
r = radius

$\bar{x} = 1/3\ b$ (right triangle)
$\bar{y} = 1/3\ h$ (measured from the 90^{o} corner)

$\bar{x} = 2/3\ b$
$\bar{y} = 2/3\ h$ (right triangle)("flipped")

---

triangle: $A = 1/2\ bh$
rectangle: $A = bh$
circle: $A = \pi r^2$
semicirle: $A = \frac{\pi r^2}{2}$

$MA_x = \bar{y}A$
$MA_y = \bar{x}A$

$\bar{x} = \frac{MA_y}{A_T}$; $\bar{y} = \frac{M_{Ax}}{A_T}$

MA = area moment (area times distance from centroid to base line)

A = area
A_T = total area (centroid of complex cross-sections)

$I_{xx} = bh^3/12$
$I_{yy} = hb^3/12$ (rectangle)

$I_{xx} = \pi r^4/4$
$I_{yy} = \pi r^4/4$ (circle)

$I_{xx} = bh^3/36$
$I_{yy} = hb^3/36$ (triangle)

$I_{xx} = 0.035\ \pi r^4$
$I_{yy} = \pi r^4/8$ (semicircle)

$I_{AA} = I_{xx} + Ad^2$ (Transfer formula)

$I_{xx} = \Sigma I_{xx} + \Sigma Ad^2$

I_{xx} = moment of inertia
I_{yy} = moment of inertia

I_{AA} = moment of inertia about the AA axis

d = distance between two axes

Table 17. Course evaluation.

COURSE EVALUATION

Directions: The purpose of this evaluation is to get your honest observations and comments on the instructional procedures and techniques used in this course. Mark your answers in columns 1-50 on the answer sheet but do not put your name or ID number on it. Use the following code:

(0) Not applicable (NA)
(1) Strongly Disagree (SD)
(2) Disagree (D)
(3) Neutral (N)
(4) Agree (A)
(5) Strongly Agree (SA)

1. I would classify the type of instruction used in this course as:

   (1) lecture-based, (2) individually-paced, (3) other

2. The Summative Test (Pre- and Post-test) was an accurate measure of my engineering skills in this course.

   (0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

3. I was enthusiastic and receptive to this method of instruction.

   (0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

4. I would recommend this course to a friend.

   (0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

5. The instructor made himself readily available.

   (0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

6. This course was intellectually stimulating to me.

   (0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

7. The course material was easy to follow.

   (0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

8. The instructor had a good understanding of the subject matter.

   (0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

9. This course was quite boring.

   (0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

10. I have frequently postponed work for this course because of demands from other courses not taught by this method.

    (0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

11. In relation to other courses, the workload in this course was much heavier.

    (0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

12. The sequence of materials presented in this course was excellent.

    (0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

13. The course material was easily understood.

    (0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

14. The tests were too difficult.

    (0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

15. I would have learned more in this course with another method of instruction.

    (0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

16. The pace of this course was too fast.

    (0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

17. The instructor was quite helpful.

    (0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

18. Formal lecture would be the best way to conduct this course.

    (0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

19. There were times when I felt prepared to take a module post-test, but the thought of having to get a certain percentage of the items correct caused me to put it off.

    (0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

20. The educational value of this course is questionable.

    (0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

21. I have spent considerably more time in this course than in others.

    (0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

22. The grading system was quite fair.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

23. Rather than using modules, I would have preferred learning the material in a different manner.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

24. Not much was gained from using the media presentations.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

25. The ideas and concepts were developed too rapidly to make the media presentations useful learning devices.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

26. This course caused me to make more effective use of my study time.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

27. The amount of useful material learned in this course was negligible.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

28. I was highly motivated by this method of instruction.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

29. My overall evaluation of this course is excellent.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

30. If another course were taught in this way, I would take it.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

31. The test questions used were good.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

32. The course was not very interesting.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

33. The total amount of time I usually spent in learning the material presented in each module was:

(0) NA, (1) 1 hour or less, (2) 2-5 hours, (3) 6-10 hours, (4) 11-15 hours, (5) 16-20 hours, (6) more than 20 hours.

34. There was usually too much material to be learned in the modules.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

35. Rather than using media presentations, I learn more when other alternative methods of learning are used.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

36. When other methods of instruction are used, I learn more.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

37. The instructor played an important role in this course.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

38. This course taught me new ways to understand and evaluate problems.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

39. This method of instruction taught me to persue the subject on my own.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

40. The material presented in this course was much too difficult.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

41. Overall, the course was well organized.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

42. This was one of my poorest courses.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

43. This course increased my appreciation of the subject.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

44. The instructor had a tremendous knowledge of the subject matter.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

45. I would generally classify this method of instruction as lecture-oriented.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

46. There were too many demands placed on the student.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

47. This course stimulated me to discuss the subject in general conversation.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

48. This method of instruction enhanced student learning.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

49. There were too many students in this class for this type of instruction.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

50. It was difficult to see how I was progressing in this course.

(0) NA, (1) SD, (2) D, (3) N, (4) A, (5) SA

Table 18. Course questionnaire.

COURSE QUESTIONNAIRE

DIRECTIONS:

The purpose of this questionnaire is to get your honest observations and comments on the instructional procedures and techniques used in your engineering technology course. Circle your answers on the questionnaire but do not put your name or ID number on it. Use the following code:

(0) Not Applicable (NA)
(1) Strongly Disagree (SD)
(2) Disagree (D)
(3) Neutral (N)
(4) Agree (A)
(5) Strongly Agree (SA)

SECTION I - GENERAL INFORMATION

1. Year in school:

   (1) first year (2) second year

2. Veteran status:

   (1) non-veteran (2) veteran

3. Program of study in engineering:

   (1) civil (2) electrical (3) electromechanical (4) electronical (5) environmental

   (6) general (7) industrial (8) mechanical (9) other

4. Age in years:

   (1) 18-19 (2) 20-22 (3) 23-25 (4) 26 - 30 (5) 31-35 (6) 36-40 (7) 41-50 (8) 51 or more

5. Day versus Night student:

   (1) day student (2) night student

6. Employment status:

   (1) not employed (2) employed part-time (3) employed full-time

7. Current school status:

   (1) full-time student (2) part-time student (3) dropped out

8. I would estimate my total grade point average (A = 4.0, B = 3.0, C = 2.0, D = 1.0, F = 0.0) at TEC as:

   (1) 0.0 (2) 0.5 (3) 1.0 (4) 1.5 (5) 2.0 (6) 2.5 (7) 3.0 (8) 3.5 (9) 4.0

9. The technical engineering course I experienced difficulty in was:

(1) Highway Design (2) Surveying II (3) Statics

(4) Surveying I (5) Steel (6) Strength of Materials

(7) Hydraulics (8) Cost Estimating (9) Structural Concrete

(10) Soil Mechanics (11) Water and Sewerage

10. My reason for experiencing difficulty in this course:

(1) unable to complete requirements (2) illness or long absence

(3) relevancy of major area of study to particular course (4) other (explain _____)

SECTION II - COURSE EVALUATION

1. I would classify the type of instruction used in this course as:

(1) lecture-based (2) individually-paced (3) other

2. The Summative Test (Pre- and Post-test) was an accurate measure of my engineering skills in this course. (0) NA (1) SD (2) D (3) N (4) A (5) SA

3. I was enthusiastic and receptive to this method of instruction. (0) NA (1) SD (2) D (3) N (4) A (5) SA

4. I would recommend this course to a friend. (0) NA (1) SD (2) D (3) N (4) A (5) SA

5. The instructor made himself readily available. (0) NA (1) SD (2) D (3) N (4) A (5) SA

6. This course was intellectually stimulating to me. (0) NA (1) SD (2) D (3) N (4) A (5) SA

7. The course material was easy to follow. (0) NA (1) SD (2) D (3) N (4) A (5) SA

8. The instructor had a good understanding of the subject matter. (0) NA (1) SD (2) D (3) N (4) A (5) SA

9. This course was quite boring. (0) NA (1) SD (2) D (3) N (4) A (5) SA

10. I have frequently postponed work for this course because of demands from other courses not taught by this method. (0) NA (1) SD (2) D (3) N (4) A (5) SA

11. In relation to other courses, the workload in this course was much heavier. (0) NA (1) SD (2) D (3) N (4) A (5) SA

12. The sequence of materials presented in this course was excellent. (0) NA (1) SD (2) D (3) N (4) A (5) SA

13. The course material was easily understood. (0) NA (1) SD (2) D (3) N (4) A (5) SA

14. The tests were too difficult. (0) NA (1) SD (2) D (3) N (4) A (5) SA

15. I would have learned more in this course with another method of instruction. (0) NA (1) SD (2) D (3) N (4) A (5) SA

16. The pace of this course was too fast. (0) NA (1) SD (2) D (3) N (4) A (5) SA

17. The instructor was quite helpful. (0) NA (1) SD (2) D (3) N (4) A (5) SA

18. Formal lecture would be the best way to conduct this course. (0) NA (1) SD (2) D (3) N (4) A (5) SA

19. There were times when I felt prepared to take a module post-test, but the thought of having to get a certain percentage of the items correct caused me to put it off. (0) NA (1) SD (2) D (3) N (4) A (5) SA

20. The educational value of this course is questionable. (0) NA (1) SD (2) D (3) N (4) A (5) SA

21. I have spent considerably more time in this course than in others. (0) NA (1) SD (2) D (3) N (4) A (5) SA

22. The grading system was quite fair. (0) NA (1) SD (2) D (3) N (4) A (5) SA

23. Rather than using modules, I would have preferred learning the material in a different manner. (0) NA (1) SD (2) D (3) N (4) A (5) SA

24. Not much was gained from using the media presentations. (0) NA (1) SD (2) D (3) N (4) A (5) SA

25. The ideas and concepts were developed too rapidly to make the media presentations useful learning devices. (0) NA (1) SD (2) D (3) N (4) A (5) SA

26. This course caused me to make more effective use of my study time. (0) NA (1) SD (2) D (3) N (4) A (5) SA

27. The amount of useful material learned in this course was negligible. (0) NA (1) SD (2) D (3) N (4) A (5) SA

28. I was highly motivated by this method of instruction. (0) NA (1) SD (2) D (3) N (4) A (5) SA

29. My overall evaluation of this course is excellent. (0) NA (1) SD (2) D (3) N (4) A (5) SA

30. If another course were taught in this way, I would take it. (0) NA (1) SD (2) D (3) N (4) A (5) SA

31. The test questions used were good. (0) NA (1) SD (2) D (3) N (4) A (5) SA

32. The course was not very interesting. (0) NA (1) SD (2) D (3) N (4) A (5) SA

33. The total amount of time I usually spent in learning the material presented in each module was:

(0) NA, (1) 1 hour or less, (2) 2-5 hours, (3) 6-10 hours, (4) 11-15 hours, (5) 16-20 hours, (6) more than 20 hours.

34. There was usually too much material to be learned in the modules. (0) NA (1) SD (2) D (3) N (4) A (5) SA

35. Rather than using media presentations, I learn more when other alternative methods of learning are used. (0) NA (1) SD (2) D (3) N (4) A (5) SA

36. When other methods of instruction are used, I learn more. (0) NA (1) SD (2) D (3) N (4) A (5) SA

37. The instructor played an important role in this course. (0) NA (1) SD (2) D (3) N (4) A (5) SA

38. This course taught me new ways to understand and evaluate problems. (0) NA (1) SD (2) D (3) N (4) A (5) SA

39. This method of instruction taught me to pursue the subject on my own. (0) NA (1) SD (2) D (3) N (4) A (5) SA

40. The material presented in this course was much too difficult. (0) NA (1) SD (2) D (3) N (4) A (5) SA

41. Overall, the course was well organized. (0) NA (1) SD (2) D (3) N (4) A (5) SA

42. This was one of my poorest courses. (0) NA (1) SD (2) D (3) N (4) A (5) SA

43. This course increased my appreciation of the subject. (0) NA (1) SD (2) D (3) N (4) A (5) SA

44. The instructor had a tremendous knowledge of the subject matter. (0) NA (1) SD (2) D (3) N (4) A (5) SA

45. I would generally classify this method of instruction as lecture-oriented. (0) NA (1) SD (2) D (3) N (4) A (5) SA

46. There were too many demands placed on the student. (0) NA (1) SD (2) D (3) N (4) A (5) SA

47. This course stimulated me to discuss the subject in general conversation. (0) NA (1) SD (2) D (3) N (4) A (5) SA

48. This method of instruction enhanced student learning. (0) NA (1) SD (2) D (3) N (4) A (5) SA

49. There were too many students in this class for this type of instruction. (0) NA (1) SD (2) D (3) N (4) A (5) SA

50. It was difficult to see how I was progressing in this course. (0) NA (1) SD (2) D (3) N (4) A (5) SA

SECTION III - COURSE COMMENTS

List the three major limitations of the method of instruction you received.

1.

2.

3.

List the three most effective ways of improving your class performance in this method of instruction.

1.

2.

3.

EVALUATIVE POSTTEST INFORMATION SHEET

NAME_____ ID#_____

COURSE TITLE_____ MODULE #_____

MEDIA PRESENTATION #(s)_____(if applicable)

The purpose of this information sheet is to get your honest observations and comments on the instructional procedures and materials used in this course. For the following statements, circle the most appropriate alternative. Use the following code:

(0) Not Applicable (NA) (1) Strongly Disagree (SD) (2) Disagree (D)

(3) Neutral (N) (4) Agree(A) (5) Strongly Agree (SA)

1. The test I am about to take serves the purpose of a:

   (1) pretest (2) first posttest (3) second posttest (4) third posttest

2. The sequence of materials presented in the module was excellent.

   (0) NA (1) SD (2) D (3) N (4) A (5) SA

3. The material in the module was easily understood.

   (0) NA (1) SD (2) D (3) N (4) A (5) SA

4. Rather than using the module, I would have preferred learning the material in a different manner.

   (0) NA (1) SD (2) D (3) N (4) A (5) SA

5. There was too much material to be learned in this module.

   (0) NA (1) SD (2) D (3) N (4) A (5) SA

6. The total amount of time I actually spent in learning the material presented in this module was:

   (1) 1 hour or less (2) 2-5 hours (3) 6-10 hours (4) 11-15 hours

   (5) 16-20 hours (6) more than 20 hours

7. The number of media presentations I viewed for this module was:

   (1) 0 (2) 1 (3) 2 (4) 3 (5) 4

8. Not much was gained from using the media presentation(s).

   (0) NA (1) SD (2) D (3) N (4) A (5) SA

9. Rather than using media presentations, I learn more when other alternative methods of learning are used.

   (0) NA (1) SD (2) D (3) N (4) A (5) SA

10. The ideas and concepts were developed too rapidly to make the media presentations useful learning devices.

    (0) NA (1) SD (2) D (3) N (4) A (5) SA

Table 20. Instructor questionnaire.

INSTRUCTOR QUESTIONNAIRE

NAME_____

COURSE TITLE_____

INSTITUTION_____

TYPE OF INSTRUCTION (circle one):

(1) Lecture-based (2) Individually-paced

The three major advantages of this type of instruction are:

1.

2.

3.

The three major disadvantages of this type of instruction are:

1.

2.

3.

For the following statements, circle the most appropriate alternative:

1. The Summative Test (Pre- and Post-test) was an accurate measure of the students' civil engineering skills in this course.

   (1) strongly disagree (2) disagree (3) neutral (4) agree (5) strongly agree

2. This type of instruction was beneficial to the students.

   (1) strongly disagree (2) disagree (3) neutral (4) agree (5) strongly agree

3. The students were enthusiastic and receptive to this method of instruction.

   (1) strongly disagree (2) disagree (3) neutral (4) agree (5) strongly agree

UNIVERSITY OF CALIF.
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JAN 21 1977

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